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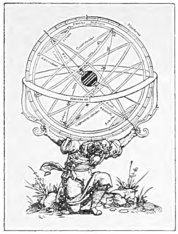

# ON THE FLORA OF AUSTRALIA,

ITS ORIGIN, AFFINITIES, AND DISTRIBUTION.

ON

# THE FLORA OF AUSTRALIA,

## ITS ORIGIN, AFFINITIES, AND DISTRIBUTION;

BEING AN

## Introductory Essay

TO THE

## FLORA OF TASMANIA.

BY

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## ON THE FLORA OF AUSTRALIA.

§ 1.

*General Remarks.*

ERRATA.

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# INTRODUCTORY ESSAY

TO

# THE FLORA OF TASMANIA.*

## § 1.

### *Preliminary Remarks.*

The Island of Tasmania does not contain a vegetation peculiar to itself, nor constitute an independent botanical region. Its plants are, with comparatively few exceptions, natives of extratropical Australia; and I have consequently found it necessary to study the vegetation of a great part of that vast Continent, in order to determine satisfactorily the nature, distribution, and affinities of the Tasmanian Flora.

From the study of certain extratropical genera and species in their relation to those of Tasmania, I have been led to the far more comprehensive undertaking of arranging and classifying all the Australian plants accessible to me. This I commenced in the hope of being able thereby to extend our knowledge of the affinities of its Flora, and, if possible, to throw light on a very abstruse subject, viz. the origin of its vegetation, and the sources or causes of its peculiarity. This again has induced me to proceed with the inquiry into the origin and distribution of existing species; and, as I have already treated of these subjects in the Introduction to the New Zealand Flora, I now embrace the opportunity afforded me by a similar Introduction to the Tasmanian Flora, of revising the opinions I then entertained, and of again investigating the whole subject of the creation of species by variation, with the aid of the experience derived from my subsequent studies of the Floras of India and Australia in relation to one another and to those of neighbouring countries, and of the recently published hypotheses of Mr. Darwin and Mr. Wallace.

No general account of the Flora of Australia having hitherto been published, nor indeed a complete Flora of any part of it, I have been obliged, as a preliminary measure, to bring together and arrange the scattered materials (both published and unpublished) relating to its vegetation to which I had access. Those which are published consist of very numerous papers relating to the general botany of Australia, in scientific periodicals, and appended to books of travel, amongst which by far the most important are Brown's 'General Remarks, Geographical and Systematical, on the Botany of Terra Australis,' published in the Appendix to Captain Flinders' Voyage, now nearly half a century ago; Allan Cunningham's Appendix to Captain King's Voyage, which appeared in 1827; Lindley's Report on the Swan River Botany; and Mueller's, on the Tropical Botany of Australia. There are also some special essays or descriptive works on the Floras of certain parts of the continent: of

* Reprinted from the first volume of Dr. Hooker's 'Flora of Tasmania;' published in June, 1859.

these the most important are Brown's 'Prodromus,' of which the only published volume appeared in 1810; the 'Plantæ Preissianæ,' edited by Professor Lehmann, and containing descriptions, by various authors, of about 2250 species (including Cryptogamiæ) of Swan River plants; Dr. Mueller's various Reports on the Flora of Victoria, and his numerous papers on the vegetable productions of that colony; and Lindley's Appendices to Mitchell's Travels.

The unpublished materials chiefly consist of the vast collections of Australian plants made during the last half-century, and these having been obtained from all parts of the continent, and carefully ticketed as to locality, etc., supply abundant materials for the investigation of the main features of the Australian Flora. In another part of this Essay I propose to give a short summary of the labours of the individuals by whom these and other Australian collections have been principally obtained, and of the routes followed by the expeditions which they accompanied.

The majority of the collections were, either wholly or in part, transmitted to Sir William Hooker, forming the largest Australian herbarium in existence, and of which the published portion is in value greatly exceeded by the unpublished; for although about two-thirds of the plants have been described, only about half of these have been brought together in a systematic form; nor, since the publication of Brown's Appendix to Flinders' Voyage, has the Flora of the whole continent been considered from a general point of view. And, before entering on the field of inquiry so successfully explored by Brown half a century ago, I must pay my tribute to the sagacity and research exhibited in the essay to which I have alluded. At the time of its publication, not half the plants now described were discovered, vast areas were yet unexplored, and far too little was known of the vegetation of the neighbouring islands to admit of the Australian Flora being studied in its relation to that of other countries. Nevertheless we are indebted to Brown's powers of generalization for a plan of the entire Flora, constructed out of fragmentary collections from its different districts, which requires but little correction from our increased knowledge, though necessarily very considerable amplification. Although he could not show the extent and exact nature of its affinities, he could predict many of them, and by his detection of the representatives of plants of other countries under the masks of structural peculiarity which disguise them in Australia, he long ago gave us the key to the solution of some of those great problems of distribution and variation, which were then hardly propounded, but which are now prominent branches of inquiry with every philosophical naturalist.

In the Introductory Essay to the New Zealand Flora, I advanced certain general propositions as to the origin of species, which I refrained from endorsing as articles of my own creed: amongst others was the still prevalent doctrine that these are, in the ordinary acceptation of the term, created as such, and are immutable. In the present Essay I shall advance the opposite hypothesis, that species are derivative and mutable; and this chiefly because, whatever opinions a naturalist may have adopted with regard to the origin and variation of species, every candid mind must admit that the facts and arguments upon which he has grounded his convictions require revision since the recent publication by the Linnean Society of the ingenious and original reasonings and theories of Mr. Darwin and Mr. Wallace.

Further, there must be many who, like myself, having hitherto refrained from expressing any positive opinion, now, after a careful consideration of these naturalists' theories, find the aspect of the question materially changed, and themselves freer to adopt such a theory as may best harmonize with the facts adduced by their own experience.

The Natural History of Australia seemed to me to be especially suited to test such a theory, on account of the comparative uniformity of its physical features being accompanied with a great variety in its Flora; of the differences in the vegetation of its several parts; and of the peculiarity both of its Fauna and Flora, as compared with those of other countries. I accordingly prepared a classified catalogue of all the Australian species in the Herbarium, with their ranges in longitude, latitude, and elevation, as far as I could ascertain them, and added what further information I could obtain from books. At the same time I made a careful study of the affinities and distribution of all the Tasmanian species, and of all those Australian ones which I believed to be found in other countries. I also determined as accurately as I could the genera of the remainder, and especially of those belonging to genera which are found in other countries, and I distinguished the species from one another in those genera which had not been previously arranged. In this manner I have brought together evidence of nearly 8000 flowering plants having been collected or observed in Australia, of which I have seen and catalogued upwards of 7000. About two-thirds of these are ascertained specifically with tolerable accuracy, and the remainder are distinguished from one another, and referred to genera with less certainty, being either undescribed, or described under several names, whilst some are members of such variable groups that I was left in doubt how to dispose of them.

To many who occupy themselves with smaller and better worked botanical districts, such results as may be deduced from the skeleton Flora I have compiled for Australia may seem too crude and imperfect to form data from which to determine its relations. But it is not from a consideration of specific details that such problems as those of the relations of Floras and the origin and distribution of organic forms will ever be solved, though we must eventually look to these details for proofs of the solutions we propose. The limits of the majority of species are so undefinable that few naturalists are agreed upon them;* to a great extent they are matters of opinion, even amongst those persons who believe that species are original and immutable creations; and as our knowledge of the forms and allies of each increases, so do these differences of opinion; the progress of systematic science being, in short, obviously unfavourable to the view that most species are limitable by descriptions or characters, unless large allowances are made for variation. On the other hand, when dealing with genera, or other combinations of species, all that is required is that these be classified in natural groups; and that such groups are true exponents of affinities settled by Nature is abundantly capable of demonstration. It is to an investigation of the extent, relations, and proportions of these natural combinations of species, then, that we must look for the means of obtaining and expressing the features of a Flora; and if in this instance the exotic species are well ascertained, it matters little whether or not the endemic are in all cases accurately distinguished from one another. Further, in a Flora so large as that of Australia, if the species are limited and estimated by one mind and eye, the errors made under each genus will so far counteract one another, that the mean results for the genera and orders will scarcely be affected. As it is, the method adopted has absorbed many weeks of labour during the last five years, and a much greater degree of accuracy could only have been obtained by a disproportionately greater outlay of time, whilst it would not have materially affected the general results.

With regard to my own views on the subjects of the variability of existing species and the fallacy of supposing we can ascertain anything through these alone of their ancestry or of originally created types, they are, in so far as they are liable to influence my estimate of the value of the facts collected for the analysis of the Australian Flora, unaltered from those which I maintained in the

* The most conspicuous evidence of this lies in the fact, that the number of known species of flowering plants is by some assumed to be under 80,000, and by others over 150,000.

'Flora of New Zealand:' on such theoretical questions, however, as the origin and ultimate permanence of species, they have been greatly influenced by the views and arguments of Mr. Darwin and Mr. Wallace above alluded to, which incline me to regard more favourably the hypothesis that it is to variation that we must look as the means which Nature has adopted for peopling the globe with those diverse existing forms which, when they tend to transmit their characters unchanged through many generations, are called species. Nevertheless I must repeat, what I have fully stated elsewhere, that these hypotheses should not influence our treatment of species, either as subjects of descriptive science, or as the means of investigating the phenomena of the succession of organic forms in time, or their dispersion and replacement in area, though they should lead us to more philosophical conceptions on these subjects, and stimulate us to seek for such combinations of their characters as may enable us to classify them better, and to trace their origin back to an epoch anterior to that of their present appearance and condition. In doing this, however, the believer in species being lineally related forms must employ the same methods of investigation and follow the same principles that guide the believer in their being actual creations, for the latter assumes that Nature has created species with mutual relations analogous to those which exist between the lineally-descended members of a family, and this is indeed the leading idea in all natural systems. On the other hand, there are so many checks to indiscriminate variation, so many inviolable laws that regulate the production of varieties, the time required to produce wide variations from any given specific type is so great, and the number of species and varieties known to propagate for indefinite periods a succession of absolutely identical members is so large, that all naturalists are agreed that for descriptive purposes species must be treated as if they were at their origin distinct, and are destined so to remain. Hence the descriptive naturalist who believes all species to be derivative and mutable, only differs in practice from him who asserts the contrary, in expecting that the posterity of the organisms he describes as species may, at some indefinitely distant period of time, require redescription.

I need hardly remark that the classificatory branch of Botany is the only one from which this subject can be approached, for a good system must be founded on a due appreciation of all the attributes of individual plants,—upon a balance of their morphological, physiological, and anatomical relations at all periods of their growth. Species are conventionally assumed to represent, with a great amount of uniformity, the lowest degree of such relationship; and the facts that individuals are more easily grouped into species limited by characters, than into varieties, or than species are into limitable genera or groups of higher value, and that the relationships of species are transmitted hereditarily in a very eminent degree, are the strongest appearances in favour of species being original creations, and genera, etc., arbitrarily limited groups of these.

The difference between varieties and species and genera in respect of definable limitation is however one of degree only, and if increased materials and observation confirm the doctrine which I have for many years laboured to establish, that far more species are variable, and far fewer limitable, than has been supposed, that hypothesis will be proportionally strengthened which assumes species to be arbitrarily limited groups of varieties. With the view of ascertaining how far my own experience in classification will bear out such a conclusion, I shall now endeavour to review, without reference to my previous conclusions, the impressions which I have derived from the retrospect of twenty years' study of plants. During that time I have classified many large and small Floras, arctic, temperate, and tropical, insular and continental: embracing areas so extensive and varied as to justify, to my apprehension, the assumption that the results derived from these would also be applicable to the whole vegetable kingdom. I shall arrange these results successively under three heads; viz. facts derived from a study of classification; secondly, from distribution; thirdly, from fossils; after which I shall examine the theories with which these facts should harmonize.

## § 2.

### *On the General Phenomena of Variation in the Vegetable Kingdom.*

1. All vegetable forms are more or less prone to vary as to their sensible properties, or (as it has been happily expressed in regard to all organisms), "they are in a state of unstable equilibrium."* No organ is exactly symmetrical, no two are exact counterparts, no two individuals are exactly alike, no two parts of the same individual exactly correspond, no two species have equal differences, and no two countries present all the varieties of a species common to both, nor are the species of any two countries alike in number and kind.

2. The rate at which plants vary is always slow, and the extent or degree of variation is graduated. Sports even in colour are comparatively rare phenomena, and, as a general rule, the best-marked varieties occur on the confines of the geographical area which a species inhabits. Thus the scarlet Rhododendron (*R. arboreum*) of India inhabits all the Himalaya, the Khasia Mountains, the Peninsular Mountains, and Ceylon; and it is in the centre of its range (Sikkim and the Khasia) that those mean forms occur which by a graduated series unite into one variable species the rough, rusty-leaved form of Ceylon, and the smooth, silvery-leaved form of the North-western Himalaya. A white and a rose-coloured sport of each variety is found growing with the scarlet in all these localities, but everywhere these sports are few in individuals. Also certain individuals flower earlier than others, and some occasionally twice a year, I believe in all localities.

3. I find that in every Flora all groups of species may be roughly classified into three large divisions: one in which most species are apparently unvarying; another in which most are conspicuously varying; and a third which consists of a mixture of both in more equal proportions. Of these the unvarying species appear so distinct from one another that most botanists agree as to their limits, and their offspring are at once referable by inspection to their parents; each presents several special characters, and it would require many intermediate forms to effect a graduated change from any one to another. The most varying species, on the contrary, so run into one another, that botanists are not agreed as to their limits, and often fail to refer the offspring with certainty to their parents, each being distinguished from one or more others by one or a few such trifling characters, that each group may be regarded as a continuous series of varieties, between the terms of which no hiatus exists suggesting the intercalation of any intermediate variety. The genera *Rubus, Rosa, Salix,* and *Saxifraga,* afford conspicuous examples of these unstable species; *Veronica, Campanula,* and *Lobelia,* of comparatively stable ones.

4. Of these natural groups of varying and unvarying species, some are large and some small; they are also very variously distributed through the classes, orders, and genera of the Vegetable Kingdom; but, as a general rule, the varying species are relatively most numerous in those classes, orders, and genera which are the simplest in structure.† Complexity of structure is generally ac-

* Essays: Scientific, Political, and Speculative; by Herbert Spencer: p. 280.

† Mr. Darwin, after a very laborious analysis of many Floras, finds that the species of large genera are relatively more variable than those of small; a result which I was long disposed to doubt, because of the number of variable

companied with a greater tendency to permanence in form: thus Acotyledons, Monocotyledons, and Dicotyledons are an ascending series in complexity and in constancy of form. In Dicotyledons, *Salices, Urticeæ, Chenopodiaceæ*, and other Orders with incomplete or absent floral envelopes, vary on the whole more than *Leguminosæ, Lythraceæ, Myrtaceæ*, or *Rosaceæ*, yet members of these present, in all countries, groups of notoriously varying species, as *Eucalyptus* in Australia, *Rosa* in Europe, and *Lotus, Epilobium*, and *Rubus* in both Europe and Australia. Again, even genera are divided: of the last named, most or all of the species are variable; of others, as *Epacris, Acacia*, and the majority of such as contain upwards of six or eight species, a larger or smaller proportion only are variable. But the prominent fact is, that this element of mutability pervades the whole Vegetable Kingdom; no class nor order nor genus of more than a few species claims absolute exemption, whilst the grand total of unstable forms generally assumed to be species probably exceeds that of the stable.

5. The above remarks are equally applicable to all the higher divisions of plants. Some genera and orders are as natural, and as limitable by characters, as are some species; others again, though they contain many very well-marked subordinate plans of construction, yet are so connected by intermediate forms with otherwise very different genera or orders, that it is impossible to limit them naturally. And as some of the best marked and limited species consist of a series of badly marked and illimitable varieties, so some of the most natural* and limitable orders and genera may respectively consist of only undefinable groups of genera or of species. For instance, both *Gramineæ* and *Compositæ* are, in the present state of our knowledge, absolutely limited Orders, and extremely natural ones also; but their genera are to a very eminent degree arbitrarily limited, and their species extremely variable. *Orchideæ* and *Leguminosæ* are also well-limited Orders (though

small genera and the fact that monotypic genera seldom have their variations recorded in systematic works, but an examination of his data and methods compels me to acquiesce in his statement. It has also been remarked (Bory de Saint-Vincent, Voy. aux Quatre Iles de l'Afrique) that the species of islands are more variable than those of continents, an opinion I can scarcely subscribe to, and opposed to Mr. Darwin's facts, inasmuch as insular Floras are characterized by peculiar genera, and by having few species in proportion to genera. Bisexual trees and shrubs are generally more variable than unisexual, which however is only a corollary from what is stated above regarding plants of simple structure of flower. On the whole, I think herbs are more variable than shrubby plants, and annuals than perennials. It would be curious to ascertain the relative variableness of social and scattered plants. The individuals of a social plant, in each area it is social upon, are generally very constant, but individuals from different areas often differ much. The *Pinus sylvestris, Mughus*, and *uncinata* are cases in point, if considered as varieties of one; as are the Cedars of Atlas, Algeria, and the Himalaya.

* It should be borne in mind that the term *natural*, as applied to Orders or other groups, has often a double significance; every natural order is so in the sense of each of its members being more closely related to one or more of its own group than to any of another; but the term is often used to designate an easily limited natural order, that is, one whose members are so very closely related to each other by conspicuous peculiarities that its differential characters can be expressed, and itself always recognized; these may be called *objective* Orders; *Orchideæ* and *Gramineæ* are examples. Any naturalist, endowed with fair powers of observation and generalization, recognizes the close affinity between a pseudobulbous epiphytical, and a terrestrial tuberous-rooted Orchid, or between the Bamboo and Wheat, though the differences are exceedingly great in habit and in organs of vegetation and reproduction. Other orders are as natural and may be as well limited, but having no conspicuous characters in common, and presenting many subordinate distinct plans of structure, may be regarded as *subjective*. Such are *Ranunculaceæ* and *Leguminosæ*, of which a botanist must have a special and extensive knowledge before he can readily recognize very many of their members. No degree of natural sagacity will enable an uninstructed person to recognize the close affinity of *Clematis* and *Ranunculus*, or of *Acacia* and *Cytisus*, though these are really as closely related as the Orchids and Grasses mentioned above. We do not know why some Orders are subjective and some objective; but if the theory of creation by variation is a true one, we ought through it to reach a solution.

not so absolutely as the former), but they, on the contrary, consist of comparatively exceedingly well-marked genera and species. *Melanthaceæ* and *Scrophularineæ*, on the other hand, are not limitable as Orders, and contain very many differently constructed groups; but their genera, and to a great extent their species also, are well-marked and limitable. The circumstance of a group being either isolated or having complex relations, is hence no indication of its members having the same characters.

Again, as with species, so with genera and orders, we find that upon the whole those are the best limited which consist of plants of complex floral structure: the Orders of Dicotyledons are better limited than those of Monocotyledons, and the genera of Dichlamydeæ than those of Achlamydeæ.*

Now my object in dwelling on this parallelism between the characteristics of individuals in relation to species, of species in relation to genera, and of genera in relation to Orders, is because I consider (Introd. Essay to Fl. N. Z.) that it is to the extinction of species and genera that we are indebted for our means of resolving plants into limitable genera and orders. This view is now, I believe, generally admitted, even by those who still regard species as the immutable units of the Vegetable Creation; and it therefore now remains to be seen how far we are warranted in extending it to the limitation of species by the elimination of their varieties through natural causes.†

6. The evidence of variability thus deduced from a rapid general survey of the prominent facts elicited from a study of the principles of classification, are to a certain extent tested by the behaviour of plants under cultivation, which operates either by hastening the processes of Nature (in rapidly inducing variation), or by effecting a prolepsis or anticipation of those processes (in producing sports, *i. e.* better marked varieties, without graduated stages), or by placing the plant in conditions to which it would never have been exposed in the ordinary course of natural events, and which eventually either kill it or give origin to a series of varieties which might otherwise have never existed.‡

* There are too many exceptions to this to admit of our concluding at once that it is attributable to any simple and uniform law of variation; but it may be explained by assuming that the degree or amount of variation is differently manifested at different epochs in the history of the group. Thus, if a genus is numerically increasing, and consequently running into varieties, it will present a group of species with complex relations *inter se;* if, on the contrary, it is numerically decreasing, such decrease must lead to the extinction of some varieties, and hence result in the better limitation of the remainder. The application of this assumption to the fact of the best limited groups being most prevalent among the higher classes (*i. e.* among those most complicated in their organization), would at first sight appear an argument against progression, were it not for the consideration that the higher tribes of plants have in another respect proved themselves superior, in that they have not only far surpassed the lower in number of genera and species, but in individuals, and also in bulk and stature. And lastly, as all the highest orders of plants contain numerous species and often genera of as simple organization as any of the lower orders are, it follows that that physical superiority which is manifested in greater extent of variation, in better securing a succession of race, in more rapid multiplication of individuals, and even in increase of bulk, is in some senses of a higher order than that represented by mere complexity or specialization of organ.

† It follows as a corollary to the proposition (That species, etc., are naturally rendered limitable by the destruction of varieties), that there must be some intimate relation between the rate of increase and the duration of genera (or other groups of species) on the one hand, and the limitability of their species on the other. Thus, when a genus consists of a multitude of illimitable forms, we may argue with much plausibility that it is on the increase, because no intermediates have as yet been destroyed, and that the birth of individuals and the production of new forms is proceeding at a greater proportional rate than in an equally large genus of which the species are limitable.

‡ My friend Mr. Wallace treats of animals under domestication, not only as if they were in very different physical conditions from those in a state of nature, inasmuch as every sense and faculty is continually fully exercised and strengthened by wild animals, whilst certain of these lie dormant in the domesticated, but as if they were

7. Now the prominent phenomena presented by species under cultivation are analogous in kind and extent to those which we have derived from a survey of the affinities of plants in a state of nature: a large number remain apparently permanent and unalterable, and a large number vary indefinitely. Of the permanent there is little to remark, except that they belong to very many orders of plants, nor are they always those which are permanent in a state of nature. Many plants, acknowledged by all to be varieties, may be propagated by seed or otherwise, when their offspring retains for many successive generations the characters of the variety. On the other hand, species which have remained immutable for many generations under cultivation, do at length commence to vary, and having once begun, are thereafter peculiarly prone to vary further.

8. The variable cultivated species present us with the most important phenomena for investigating the laws of mutability and permanence; but these phenomena are so infinitely varied, complex, and apparently contradictory, as to defeat all attempts to elucidate the history of any individual case of variation by a study of its phases alone. It would often appear doubtful whether the natural operations of a plant tend most to induce or to oppose variation; and we hence find the advocates of original permanent creations, and those of mutable variable species, taking exactly opposite views in this respect, the truth, I believe, being that both are right. Nature has provided for the possibility of indefinite variation, but she regulates it as to extent and duration; she will neither allow her offspring to be weakened or exhausted by promiscuous hybridization and incessant variation, nor will she suffer a new combination of external conditions to destroy one of these varieties without providing a substitute when necessary; hence some species remain so long hereditarily immutable as to give rise to the doctrine that all are so normally, while others are so mutable as to induce a belief in the very opposite doctrine, which demands incessant lawless change.

9. It would take far too long a time were I to attempt any analysis of the phenomena of cultivation, as illustrative of those of variability in a state of nature. There are however some broad facts which should be borne in mind in treating of variation by cross impregnation and hybridity.

10. Variation is effected by graduated changes; and the tendency of varieties, both in nature and under cultivation, when further varying, is rather to depart more and more widely from the original type, than to revert to it: the best marked varieties of a wild species occurring on the confines of the area the species inhabits, and the best marked varieties of the cultivated species being those last produced by the gardener. I am aware that the prevalent opinion is that there is a strong tendency in cultivated, and indeed in all varieties, to revert to the type from which they departed; and I have myself quoted this opinion, without questioning its accuracy,* as tending to sup-

subject to the influence of fundamentally different laws. He says, "No inferences as to varieties in a state of nature can be deduced from the observation of those occurring among domestic animals. The two are so much opposed that what applies to the one is almost sure not to apply to the other." But, in the first place, of the same species of wild animals some families must be placed where certain faculties and senses are far more exercised than others, and the difference in this respect between the conditions of many families of wild animals is as great as those between many wild and tame families; and secondly, other senses and faculties, latent and unknown in the wild animal, but which are as proper to the species as any it exercised in its wild state, are manifested or developed by it under domestication. An animal in a state of nature is not then, as Mr. Wallace assumes, "in the full exercise of every part of its organization;" were it so, it could not vary or alter with altered conditions, nor could other faculties remain to be called into play under domestication. The tendency of species when varying cannot be to depart from the original type in a wild condition and to revert to it under domestication, for man cannot invert the order of Nature, though he may hasten or retard some of its processes.

* Fl. N. Zeal., Introd. Essay, p. x., and Flora Indica, Introduction, p. 14.

port the views of those who regard species as permanent. A further acquaintance with the results of gardening operations leads me now to doubt the existence of this centripetal force in varieties, or at least to believe that in the phrase "reversion to the wild type," many very different phenomena are included. In the first place, the majority of cultivated vegetables and cerealia, such as the Cabbage and its numerous progeny, and the varieties of wall-fruit, show when neglected no disposition to assume the characters of the wild states of these plants;* they certainly degenerate, and even die if Nature does not supply the conditions which man (by anticipation of her operations, or otherwise) has provided; they become stunted, hard, and woody, and resemble their wild progenitors in so far as all stunted plants resemble wild plants of similar habit; but this is not a reversion to the original type, for most of these cultivated races are not *merely* luxuriant forms of the wild parent. In neglected fields and gardens we see plants of Scotch Kale, Brussels Sprouts, or Kohl-rabi, to be all as unlike their common parent, the wild *Brassica oleracea,* as they are unlike one another; so, too, most of our finer kinds of apples, if grown from seed, degenerate and become crabs, but in so doing they become crab states of the varieties to which they belong, and do not revert to the original wild Crab-apple. And the same is true to a great extent of cultivated Roses, of many varieties of trees, of the Raspberry, Strawberry, and indeed of most garden plants. It has also been held, that by imitating the conditions under which the wild state of a cultivated variety grows, we may induce that variety to revert to its original state; but, except in the false sense of reversion above explained, I doubt if this is supported by evidence. Cabbages grown by the seaside are not more like wild Cabbages than those grown elsewhere, and if cultivated states disseminate themselves along the coast, they there retain their cultivated form. This is however a subject which would fill a volume with most instructive matter for reflection, and which receives a hundredfold more illustration from the Animal than from the Vegetable Kingdom. I can here only indicate its bearing on the doctrine of variation, as evidence that Nature operates upon mutable forms by allowing great variation, and displaying little tendency to reversion.† With this law the suggestive observation of M. Vilmorin well accords, that when once the constitution of a plant is so broken that variation is induced, it is easy to multiply the varieties in succeeding generations.

It may be objected to this line of argument that our cultivated plants are, as regards their constitution, in an artificial condition, and are, if unaided, incapable of self-perpetuation; but an artificially induced condition of constitution is not necessarily a diseased or unnatural one, and, so far as our cultivated plants are concerned, all we do is to place them under conditions which Nature does not provide *at the same particular place and time.* That Nature might supply the conditions at other places and times may be inferred from the fact that the plant is found to be provided with the means of availing itself of them when provided, while at the same time it retains all its functions, not only unimpaired, but in many cases in a more highly developed state. We have no reason to suppose that we have violated Nature's laws in producing a new variety of wheat,—we may have only anticipated them; nor is its constitution impaired because it cannot, unaided, perpetuate its race; it is in as sound and unbroken health and vigour during its life as any wild variety is, but its offspring

* Hence the great and acknowledged difficulty of determining the wild parent species of most of our cultivated fruits, cerealia, etc., and in fact of almost every member of our Flora Cibaria. This would not be so were there any disposition in the neglected cultivated races to revert to the wild form.

† It is not meant by this that any character of a species which may be lost in its variety never reappears in the descendants of the latter, for some occasionally do so in great force; what is meant is, that the newly acquired characters of the variety are never so entirely obliterated that it has no longer a claim to be considered a variety.

has so many enemies that they do not perpetuate its race. In the case of annual plants, those only can secure the succession of their species which produce more seeds annually than can be eaten by animals or destroyed by the elements. Cultivated wheat will grow and ripen its seed in almost all soils and climates, and as its seeds are produced in great abundance, and can be preserved alive in any quantity, in the same climate, and for many years, it follows that it is not to the artificial or peculiar condition of the plant itself, and still less to any change effected by man upon it, that its annual extinction is due, but to causes that have no effect whatever upon its own constitution, and over which its constitutional peculiarities can exercise no control.

11. Again, the phenomena of cross impregnation amongst individuals of all species appear, according to Mr. Darwin's accurate observations, to have been hitherto much underrated, both as to extent and importance. The prominent fact that the stamens and pistil are so often placed in the same flower, and come to maturity at the same epoch, has led to the doctrine that flowers are usually self-impregnated, and that the effect is a conservative one as regards the permanence of specific forms. The observations of Carl Sprengel and others have, however, proved that this is not always the case, and that while Nature has apparently provided for self-fertilization, she has often insidiously counteracted its operation, not only by placing in flowers lures for insects which cross-fertilize them, but often by interposing insuperable obstacles to self-fertilization, in the shape of structural impediments to the access of the pollen to the stigma of its own flower.* In all these instances the double object of Nature may be traced; for self-impregnation (or "breeding in"), while securing identity of form in the offspring, and hence hereditary permanence, at the same time tends to weakness of constitution, and hence to degeneracy and extinction: on the other hand, cross-impregnation, while tending to produce diversity of form in the offspring, and hence variation and apparent mutability, yet by strengthening the offspring favours longevity and apparent permanence of specific type. The ultimate effect of all these operations is of course favourable to the hypothesis that variability is the rule, and permanence the exception, or at any rate only a transitory phenomenon.

12. Hybridization, or cross-impregnation between species or very well marked varieties, again, is a phenomenon of a very different kind, however similar it may appear in operation and analogous in design. Hybridizable genera are rarer than is generally supposed, even in gardens, where they are so often operated upon, under circumstances the most favourable to the production of a hybrid, and unfavourable to self-impregnation. Hybrids are almost invariably barren, and their characters are not those of new varieties. The obvious tendency of hybridization between varieties or other very closely allied forms (in which case the offspring may be fertile) is not to enlarge the bounds of variation, but to contract them; and if between very different forms, it will only tend to confound these. That some supposed species may have their origin in hybridization cannot be denied, but we are now dealing with phenomena on a large scale, and balancing the tendencies of causes uniformly acting, whose effects are unmistakable, and which can be traced throughout the Vegetable Kingdom. In gardening operations the number of hybridized genera is small, their offspring doomed, and since they are more readily impregnated by the pollen of either parent than by their own,

* Thus, in *Lobelia fulgens*, the pollen is entirely prevented by natural causes from reaching the stigma of its own flower. In kidney beans impregnation takes place imperfectly except the carina is worked up and down artificially, which is effected by bees, who may thus either impregnate the flower with its own pollen or with that brought from another plant. I am indebted to Mr. Darwin for both these facts: see 'Gardeners' Chronicle,' 1858, p. 828.

or by that of any other plant,* they eventually revert to one of their parents: on the other hand, the number of varieties is incalculable, the power to vary further is unimpaired in their progeny, and these tend to depart further and further in sensible properties from the original parent.

In conformity with my plan of starting from the variable and not the fixed aspect of Nature, I have now set down the prominent features of the Vegetable Kingdom, as surveyed from this point of view. From the preceding paragraphs the evidence appears to be certainly in favour of proneness to change in individuals, and of the power to change ceasing only with the life of the individual; and we have still to account for the fact that there are limits to these mutations, and laws that control the changes both as to degree and kind; that species are neither visionary nor even arbitrary creations of the naturalist; that they are, in short, realities, whether only temporarily so or not.

13. Granting then that the tendency of Nature is first to multiply forms of existing plants by graduated changes, and next by destroying some to isolate the rest in area and in character, we are now in a condition to seek some theory of the *modus operandi* of Nature that will give temporary permanence of character to these changelings. And here we must appeal to theory or speculation; for our knowledge of the history of species in relation to one another, and to the incessant mutations of their environing physical conditions, is far too limited and incomplete to afford data for demonstrating the effects of these in the production of any one species in a native state.

Of these speculations by far the most important and philosophical is that of the delimitation of species by natural selection, for which we are indebted to two wholly independent and original thinkers, Mr. Darwin and Mr. Wallace.† These authors assume that all animal and vegetable forms are variable, that the average amount of space and annual supply of food for each species (or other group of individuals) is limited and constant, but that the increase of all organisms tends to proceed annually in a geometrical ratio; and that, as the sum of organic life on the surface of the globe does not increase, the individuals annually destroyed must be incalculably great; also that each species is ever warring against many enemies, and only holding its own by a slender tenure. In the ordinary course of nature this annual destruction falls upon the eggs or seeds and young of the organisms, and as it is effected by a multitude of antagonistic, ever-changing natural causes, each more destructive of one organism than of any other, it operates with different effect on each group of individuals, in every locality, and at every returning season. Here then we have an infinite number of varying conditions, and a superabundant supply of variable organisms, to accommodate themselves to these conditions. Now the organisms can have no power of surviving any change in these conditions, except they are endowed with the means of accommodating themselves to it. The exercise of this power may be accompanied by a visible (morphological) change in the form or structure of the individual, or it may not, in which case there is still a change, but a physiological one, not outwardly

* A very able and careful experimenter, M. Naudin, performed a series of experiments at the Jardin des Plantes at Paris, in order to discover the duration of the progeny of fertile hybrids. He concludes that the fertile posterity of hybrids disappears, to give place to the pure typical form of one or other parent. "Il se peut sans doute qu'il y ait des exceptions à cette loi de retour, et que certains hybrides, à la fois très-fertiles et très-établis, tendent à faire souche d'espèce; mais le fait est loin d'être prouvé. Plus nous observons les phénomènes d'hybridité, plus nous inclinons à croire que les espèces sont indissolublement liées à une fonction dans l'ensemble des choses, et que c'est le rôle même assigné à chacune d'elles qui en détermine la forme, la dimension et la durée." (Annales des Sc. Nat. sér. 4. v. 9.)

† Journal of the Linnean Society of London, Zoology, vol. iii. p. 45.

manifested; but there is always a morphological change if the change of conditions be sudden, or when, through lapse of time, it becomes extreme. The new form is necessarily that best suited to the changed condition, and as its progeny are henceforth additional enemies to the old, they will eventually tend to replace their parent form in the same locality. Further, a greater proportion of the seeds and young of the old will annually be destroyed than of the new, and the survivors of the old, being less well adapted to the locality, will yield less seed, and hence have fewer descendants.

In the above operations Nature acts slowly on all organisms, but man does so rapidly on the few he cultivates or domesticates; he selects an organism suited to his own locality, and by so modifying its surrounding conditions that the food and space that were the share of others falls to it, he ensures a perpetuation of his variety, and a multiplication of its individuals, by means of the destruction of the previous inhabitants of the same locality; and in every instance, where he has worked long enough, he finds that changes of form have resulted far greater than would suffice to constitute conventional species amongst organisms in a state of nature, and he keeps them distinct by maintaining these conditions.

Mr. Darwin adduces another principle in action amongst living organisms as playing an important part in the origin of species, viz. that the same spot will support most life when peopled with very diverse forms, as is exemplified by the fact that in all isolated areas the number of Classes, Orders, and Genera is very large in proportion to that of Species.

## § 3.

### *On the General Phenomena of Distribution in Area.*

Turning now to another class of facts, those that refer to the distribution of plants on the surface of the globe, the following are the most obvious:—

14. The most prominent feature in distribution is that circumscription of the area of species, which so forcibly suggests the hypothesis that all the individuals of each species have sprung from a common parent, and have spread in various directions from it. It is true that the area of some (especially Cryptogamic and Aquatic plants) is so great that we cannot indicate any apparent centre of diffusion, and that others are so sporadic that they appear to have had many such centres; but these species, though more numerous than is usually supposed, are few in comparison with those that have a definite or circumscribed area.

With respect to this limitation in area,* species do not essentially differ from varieties on the one hand, or from genera and higher groups on the other; and indeed, in respect of distribution, they hold an exactly intermediate position between them, varieties being more restricted in locality than species, and these again more than genera.

* It is a remarkable fact that there are some striking anomalies in the distribution of plants into provinces, as compared with animals. Thus there is no peculiarity in the vegetation of Australia to be compared with the rarity of placental mammals, nor with the fact of so many of the mammals, birds, and fish of Tasmania differing from those of the continent of Australia. Nearer home, we find the basin of the Mediterranean with a tolerably uniform Flora on the European and North African sides, but these ranking as different zoological provinces. The much narrower delimitation in area of animals than plants, and greater restriction of Faunas than Floras, should lead us to anticipate that plant types are, geologically speaking, more ancient and permanent than the higher animal types are, and so I believe them to be, and I would extend the doctrine even to plants of highly complex structure.

The universality of this feature (of groups having defined areas) affords to my mind all but conclusive evidence in favour of the hypothesis of similar forms having had but one parent, or pair of parents. And further, this circumscription of species and other groups in area, harmonizes well with that principle of divergence of form, which is opposed to the view that the same variety or species may have originated at different spots. It also follows that, as a general rule, the same species will not give rise to a series of similar varieties (and hence species) at different epochs; whence the geological evidence of contemporaneity derived from identity of fossil forms may be relied upon.

The most obvious cause of this limitation in area no doubt exists in the well-known fact that plants do not necessarily inhabit those areas in which they are constitutionally best fitted to thrive and to propagate; that they do not grow where they would most like to, but where they can find space and fewest enemies. We have seen (13) that most plants are at warfare with one or more competitors for the area they occupy, and that both the number of individuals of any one species and the area it covers are contingent on the conditions which determine these remaining so nicely balanced that each shall be able at least to hold its own, and not succumb to the enervating or etiolating or smothering influences of its neighbours. The effects of this warfare are to extinguish some species, to spare only the hardier races of others, and especially to limit the remainder both as to area and characters. Exceptions occur in plants suited to very limited or abnormal conditions, such as desert plants, the chief obstacles to whose multiplication are such inorganic and principally atmospheric causes as other plants cannot overcome at all; such plants have no competitors, are generally widely distributed, and not very variable.*

15. The three great classes of plants, Acotyledons, Monocotyledons, and Dicotyledons (Gymnospermous and Angiospermous), are distributed with tolerable equality over the surface of the globe, inasmuch as we cannot indicate any of the six continents (Europe, Asia, Africa, North and South America, and Australia) as being peculiarly rich in one to the exclusion of another. Further, the distribution of some of the larger Orders is remarkably equable, as *Compositæ*, *Leguminosæ*, *Gramineæ*, and others; facts which (supposing existing species to have originated in variation) would seem to indicate that the means of distribution have overcome, or been independent of the existing apparent impediments, and that the power of variation is equally distributed amongst these classes, and continuously exerted under very different conditions. I do not mean that all the classes are equally variable, but that each displays as much variety in one continent as in another.

16. Those Classes and Orders which are the least complex in organization are the most widely distributed, that is to say, they contain a larger proportion of widely diffused species. Thus the species of Acotyledons are more widely dispersed than those of Monocotyledons, and these again more so than those of Dicotyledons; so also the species of *Thallophytes* are among the most widely dispersed of Acotyledons, the *Gramineæ* of Monocotyledons, and the *Chenopodiaceæ* of Dicotyledons. This tendency of the least complex species to be most widely diffused is most marked in Acotyledons, and least so in Dicotyledons,† a fact which is analogous to that already stated (4), that the least complex are also the most variable.

* Though invariable forms, they may be, and often are, themselves varieties or races of a species that inhabits more fertile spots, as *Poa bulbosa*, which is a very well-marked and constant form of *P. pratensis*, occurring in dry sandy soil, from England to North-western India, its "meadow" relative being a very variable species in the same countries, and always struggling for existence amongst other Grasses, etc.

† Very much, no doubt, because of the difficulty in classifying Dicotyledons by complexity of organization; in other words, of our inability to estimate in a classificatory point of view the relative value of the presence or absence

17. Though we rarely find the same species running into the same varieties at widely sundered localities (unless starved or luxuriant forms be called varieties), yet we do often find a group of species represented in many distant places by other groups of allied forms; and if we suppose that individuals of the parent type have found their way to them all, the theory that existing species have originated in variation, and that varieties depart further from the parent form, will account for such groups of allied species being found at distant spots; as also for these groups being composed of representative species and genera.

18. No general relations have yet been established between the physical conditions of a country and the number of species or varieties which it contains, further than that the tropical and temperate regions are more fertile than the polar, and that perennial drought is eminently unfavourable to vegetation. It is not even ascertained whether the tropical climates produce more species than the temperate.

19. Though we cannot explain the general relations between the vegetation and physical condition of any two countries that contrast in these respects, we may conclude as a general rule that those tracts of land present the greatest variety in their vegetation that have the most varied combinations of conditions of heat, light, moisture, and mineral characters. It is, in the present state of our knowledge, impossible to measure the amount of the fluctuations of these conflicting conditions in a given country, nor if we could can we express them symbolically or otherwise so as to make them intelligible exponents of the amount of variety in the vegetation they affect; but the following facts in general distribution appear to me to be favourable to the idea that there is such a connection.

There are certain portions of the surface of the globe characterized by a remarkable uniformity in their phænogamic vegetation. These may be luxuriantly clothed, and abound in individuals, but are always poor in species. Such are the cooler temperate and subarctic lake regions of North America, Fuegia and the Falkland Islands, the Pampas of Buenos Ayres, Siberia and North Russia, Ireland and Western Scotland, the great Gangetic plain, and many other tracts of land. Now all these regions are characterized by a great uniformity in most of their physical characters, and an absence of those varying conditions which we assume to be stimulants to variation in a locality. On the other hand, it is in those tracts that have the most broken surface, varied composition of rocks, excessive climate (within the limits of vegetable endurance), and abundance of light, that the most species are found, as in South Africa, many parts of Brazil and the Andes, Southern France, Asia Minor, Spain, Algeria, Japan, and Australia.

20. The Polar regions are chiefly peopled from the colder temperate zones, and the species from the latter which have spread into them are very variable, but only within comparatively small limits, particularly in stature, colour, and vesture. Many of these polar and colder temperate plants are also found, together with other species closely allied to them, on the mountains of the warm temperate, and even tropical zones; to which it is difficult to conceive that they can have been transported by agencies now in operation.

21. The Floras of islands present many points of interest. The total number of species they contain seems to be invariably less than an equal continental area possesses, and the relative numbers of species to genera (or other higher groups) is also much less than in similar continental areas.

The further an island is from a continent, the smaller is its Flora numerically, the more

of organs in plants, where many are present, and where those of low morphological importance may have a comparatively high physiological significance.

peculiar is its vegetation, and the smaller its proportion of species to genera. In the case of very isolated islands, moreover, the generic types are often those of very distant countries, and not of the nearest land. Thus the St. Helena and Ascension forms are not so characteristic of tropical Africa as of the Cape of Good Hope. Those of Kerguelen's Land are Antarctic American, not African nor Indian. The Sandwich Islands contain many North-west American and some New Zealand forms. Japan presents us with many genera and species unknown except to the *eastward* of the Rocky Mountains, in North America.* So too American, Abyssinian, and even South African genera and species are found in Madeira and the Canary Islands; and Fuegian ones in Tristan d'Acunha.

22. There is a strict analogy in this respect between the Floras of islands and those of lofty mountain-ranges, no doubt in both cases owing to the same causes. Thus, as Japan contains various peculiar N.E. American species which are not found in N.W. America nor elsewhere on the globe, and the Canaries and Azores possess American genera not found in Europe nor Africa, so the lofty mountains of Borneo contain Tasmanian and Himalayan representatives; the Himalayas contain Andean, Rocky Mountain, and Japanese genera and species; and the alps of Victoria and Tasmania contain assemblages of New Zealand, Fuegian, Andean, and European genera and species. We cannot account for any of these cases of distribution between islands and mountains except by assuming that the species and genera common to these distant localities have found their way across the intervening spaces under conditions which no longer exist.

23. There is much to be observed in the condition and distribution of the introduced or naturalized plants of a country, which may be applied to the study of the origin of its indigenous vegetation. The greater proportion of these are the annual and other weeds of cultivated land, and plants which attach themselves to nitrogenous soils; naturalized perennials, shrubs, and trees occur consecutively in rapidly diminishing proportions. I can find no decided relation between complexity of structure and proneness to migrate, nor much between facilities for transport or power of endurance or vitality in the seed, and extent of distribution by artificial means. I shall return to this subject (which I have elsewhere discussed at length with reference to the Galapagos Archipelago†) when treating of the naturalized plants of Australia.

24. I venture to anticipate that a study of the vegetation of islands with reference to the peculiarities of their generic types on the one hand, and of their geological condition (whether as rising or sinking) on the other, may, in the present state of our knowledge, advance the subjects of distribution and variation considerably. The incompleteness of the collections at my command from the Polynesian islands, has frustrated my attempts to illustrate this branch of inquiry by extending my researches from the Australian Flora over that of the Pacific. I may however indicate as a general result, that I find the sinking islands, those (so determined by Darwin's able investigations) characterized as atolls, or as having barrier reefs, to contain comparatively fewer species and fewer peculiar generic types than those which are rising. Thus, commencing from the east coast of Africa, I find in the Indian Ocean the following islands marked in Darwin's chart‡ as bounded with fringing reefs or active volcanos, and hence rising:—The Seychelles, Madagascar, Mauritius, Bourbon, Ceylon, the Andamans, Nicobar, and Sumatra; the vegetation of all which is characterized by great diversity and much peculiarity of generic type: whereas those marked as

* Whilst these sheets are passing through the press, I have been informed by Professor Asa Gray that the Flora of Japan and N.E. Asia is much more closely allied to that of the Northern United States than to that of America west of the Rocky Mountains.

† Linn. Trans. xx. 235.

‡ See his works on volcanic islands and on coral reefs.

atolls or barrier reefs, as the Maldives, Laccadives, and Keeling Island, contain few species, and those the same as grow on the nearest continents. In the Pacific Ocean, again, the groups of islands most remarkable for their ascertained number of very peculiar generic types are the Sandwich group, Galapagos, Juan Fernandez, Loochoo and Bonin, all of which are rising, and most have active volcanos: those with the least amount of peculiarity are the Society group and Fijis, both of which are sinking. In the present state of our knowledge it is not safe to lay much stress on these apparent facts, especially as the New Hebrides and New Caledonia, which lie very close together, and both, I believe, contain much peculiarity, are in opposite geological conditions, the Hebrides rising and Caledonia sinking; and the Friendly* and Fiji groups, equally near one another, and with, I suspect, very similar vegetation, are also represented as being in opposite conditions. On the other hand, whole of the group including the Low Archipelago and the Society Islands, extending over more than 2000 miles, I observe but one rising spot,† namely, Elizabeth Island, a mere speck of land, but which is the only known habitat of one of the most remarkable genera of *Compositæ*.‡

25. Many of the above facts in the general distribution of species cannot be wholly accounted for by the supposition that natural causes have dispersed them over such existing obstacles as seas, deserts, and mountain-chains; moreover, some of these facts are opposed to the theory that the creation of existing species has taken place subsequent to the present distribution of climates, and of land and water, and to that of their dispersion having been effected by the now prevailing aquatic, atmospheric, and animal means of transport.

Similar climates and countries, even when altogether favourably placed for receiving colonists from each other, and with conditions suitable to their reciprocal exchange, do not, as a rule, interchange species. Causes now in operation will not account for the fact that only 200 of the New Zealand Flowering Plants are common to Australia, and still less for the contrasting one that the very commonest, most numerous, and universally distributed Australian genera and species, as *Casuarina, Eucalyptus, Acacia, Boronia, Helichrysum, Melaleuca*, etc., and all the Australian *Leguminosæ* (including a European genus and species), are absent from New Zealand. Causes now in operation cannot be made to account for a large assemblage of Flowering Plants characteristic of the Indian peninsula being also inhabitants of tropical Australia, while not one characteristic Australian genus has ever been found in the peninsula of India. Still less will these causes account for the presence of Antarctic and European species in the Alps of Tasmania and Victoria, or for the reappearance of Tasmanian genera on the isolated lofty mountain of Kina-Balou, in Borneo.

These and a multitude of analogous facts have led to the study of two classes of agents, both of which may be reasonably supposed to have had a powerful effect in determining the distribution of plants; these are changes of climates, and changes in the relative positions and elevations of land.

26. Of these, that most easy of direct application is the effect of humidity in extending the

* I find that there is a remarkable difference between the Floras of the New Hebrides and Caledonia on the one hand, and those of the Fiji islands and those to the east of them on the other. In the former, New Zealand and Australian types abound; in the latter, almost exclusively Indian forms. The differences between the Floras of Fiji, Samoa, Tonga, Tahiti, and that of India, are in species and not in genera, and many species are common to all.

† Mr. Darwin has left Aurora Island (another of the group) uncoloured, on account of the doubtful evidence regarding it, which however is in favour of its being in the same condition as Elizabeth Island. From a list of species communicated by Mr. Dana, it appears to contain no peculiar plants.

‡ *Fitchia*. See Lond. Journ. Bot. 1845, iv. p. 640. t. 23, 24.

range of species into regions characterized by what would otherwise be to them destructive temperatures.

I have, in the 'Antarctic Flora,' shown that the distribution of tropical forms is extended into cold regions that are humid and equable further than into such as are dry and excessive; and, conversely, that temperate forms advance much further into humid and equable tropical regions than into dry and excessive ones; and I have attributed the extension of Tree-ferns, Epiphytal Orchids, Myrtaceæ, etc., into high southern latitudes, to the moist and equable climate of the south temperate zone. I have also shown how conspicuously this kind of climate influences the distribution of mountain plants in India, where tropical forms of Laurel, Fig, Bamboo, and many other genera, ascend the humid extratropical mountains of Eastern Bengal and Sikkim to fully 9000 feet elevation; and temperate genera, and in some cases species, of Quercus, Salix, Rosa, Pinus, Prunus, Camellia, Rubus, Kadsura, Fragaria, Æsculus, etc., descend the mountains even to the level of the sea, in lat. 25°. In a tropical climate the combined effects of an equable climate and humidity in thus extending the distribution of species, often amount to 5000 feet in elevation or depression (equivalent to 15° Fahr. of isothermals in latitude), a most important element in our speculations on the comparative range of species under existing or past conditions; and when to this is added that the average range in altitude of each Himalayan tropical and temperate and alpine species of Flowering Plant is 4000 feet, which is equivalent to 12° of isothermals of latitude, we can understand how an elevation of a very few thousand feet might, under certain climatic conditions, suffice to extend the range of an otherwise local species over at least 25° parallels of latitude, and how a proportionally small increase of elevation in a meridional chain where it crosses the Equator, may enable temperate plants to effect an easy passage from one temperate zone to the other.

27. To explain more fully the present distribution of species and genera in area, I have recourse to those arguments which are developed in the Introductory Essay to the New Zealand Flora, and which rest on geological evidence, originally established by Sir Charles Lyell, that certain species of animals have survived great relative changes of sea and land. This doctrine, which I in that Essay endeavoured to expand by a study of the distribution of existing Southern species, has, I venture to think, acquired additional weight since then, from the facts I shall bring forward under the next head of Geological Distribution, and which seem to indicate that many existing Orders and Genera of plants of the highest development may have flourished during the Eocene and Cretaceous periods, and have hence survived complete revolutions in the temperature and geography of the middle and temperate latitudes of the globe.

28. Mr. Darwin has greatly extended in another direction these views of the antiquity of many European species, and their power of retaining their *facies* unchanged during most extensive migrations, by his theory of the simultaneous extension of the glacial temperature in both hemispheres, and its consequent effect in cooling the tropical zone. He argues that, under such a cold condition of the surface of the globe, the temperate plants of both hemispheres may have been almost confined to the tropical zone, whence afterwards, owing to an increment of temperature, they would be driven up the mountains of the tropics, and back again to those higher temperate latitudes where we now find most of them. I have already (New Zealand Essay) availed myself of the hypothesis of an austral glacial period, to account for Antarctic species being found on the alps of Australia, Tasmania, and New Zealand; and if as complete evidence of such a proportionally cooled state of the intertropical regions were forthcoming as there is of a glacial condition of the temperate zones, it would amply suffice to account for the presence of European and Arctic species in the Antarctic and south tem-

perate regions, and of the temperate species of both hemispheres on the mountains of intermediate tropical latitudes.

On the other hand, we have sufficient evidence of many of what are now the most tropical Orders of plants having inhabited the north temperate zone before the glacial epoch; and it is difficult to conceive how these Orders could have survived so great a reduction of the temperature of the globe as should have allowed the preglacial temperate Flora to cross the Equator in any longitude. It is evident that, under such cold, the most tropical Orders must have perished, and their re-creation after the glacial epoch is an inadmissible hypothesis.*

29. It remains then to examine whether, supposing the glacial epochs of the northern and southern hemispheres to have been contemporaneous, the relations of land and sea may not have been such as that a certain meridian may have retained a tropical temperature near the Equator, and thus have preserved the tropical forms. Such conditions might perhaps be attained by supposing two large masses of land at either pole, which should contract and join towards the Equator, forming one meridional continent, while one equatorial mass of land should be placed at the opposite meridian. If the former continent were traversed by a meridional chain of mountains, and so disposed that the polar oceanic currents should sweep towards the Equator for many degrees along both its shores, its equatorial climate would be throughout far more temperate than that of the opposite equatorial mass of land, whose climate would be tropical, insular, and humid.

30. The hypothesis of former mountain chains having afforded to plants the means of migration, by connecting countries now isolated by seas or desert plains, is derived from the evidence afforded by geology of the extraordinary mutation in elevation that the earth's surface has experienced since the appearance of existing forms of animals and plants. In the Antarctic Flora I suggested as an hypothesis that the presence of so many Arctic-American plants in Antarctic America might be accounted for by supposing that the now depressed portions of the Andean chain had, at a former period, been so elevated that the species in question had passed along it from the north to the south temperate zone;† and there are some facts in the distribution of species common to the mountain Floras of the Himalaya and Malay Islands, and of Australia and Japan, that would well accommodate themselves to a similar hypothesis. Of such submerged meridional lands we have some slender

* The question of the state of the mean temperature of the globe during comparatively recent geological periods is yearly deriving greater importance in relation to the problem of distribution. Upon this point geologists are not altogether clear, nor at one with the masters of physical science. Lyell (Principles, ed. ix. chap. vii.) attributes the glacial epoch to such a disposition of land and sea as would sufficiently cool the temperate zones; and he implies that this involves or necessitates a lowering of the mean temperature of the whole globe. Another hypothesis is, that there was a lowering of the mean temperature of the globe wholly independent of any material change in the present relations of sea and land, which cold induced the glacial epoch. A third theory is that such a redisposition of land and sea as would induce a glacial epoch in our hemisphere need not be great, nor necessitate a decrement of the mean temperature of the whole earth.

† The continuous extension of so many species along the Cordillera (of which detailed evidence is given in the Antarctic Flora) from the Rocky Mountains to Fuegia, is a most remarkable fact, considering how great the break is between the Andes of New Granada and those of Mexico, and that the intermediate countries present but few resting-places for alpine plants. That this depression of the chain has had a powerful effect in either limiting the extension of species which have appeared since its occurrence, or in inducing changes of climate which have extinguished species once common to the north and south, is evidenced by the fact that a number of Fuegian and South Chili plants extend northward as alpines to the very shores of the Gulf of Mexico, but do not inhabit the Mexican Andes, whilst as many Arctic species advance south to the Mexican Andes, but do not cross the intermediate depression and reappear in the Bolivian Andes.

evidence in the fact that, in the meridians of Australia and Japan, we have, first, the north-west coast of Australia sinking, together with the Louisiade Archipelago to its north; then, approaching the Line, the New Ireland group is sinking, as are also the Caroline Islands, in lat. 7° N. Beyond this, however, in lat. 15° N., are the Marianne Islands (rising), of whose vegetation nothing is known; in 27° N., the Bonin Islands (also rising); and in 30° N. is Japan, with which this botanical relationship exists.

It is objected by Mr. Darwin to this line of argument (as to that at p. xv concerning the Pacific Islands), that all these sinking areas are volcanic islands, having no traces of older rocks on them; but I do not see that this altogether invalidates the hypothesis, for many of the loftiest mountains throughout the Malayan Archipelago, New Zealand, and the Pacific Islands, are volcanic; some are active, and many attain 10–14,000 feet in elevation, whilst the lower portions of some of the largest of these islands are formed of rocks of various ages.

## § 4.

### *On the General Phenomena of the Distribution of Plants in Time.*

A third class of facts relates to the antiquity of vegetable forms and types on the globe, as evidenced by fossil plants. The chief facts relating to these are the following:—

31. The earliest Flora of which we know much scientifically, is that of the Carboniferous formation. We have indeed plants that belonged to an earlier vegetation, but they do not differ in any important respects from those of the carboniferous formation.

Now the ascertained features of the coal vegetation may be summed up very briefly. There existed at that time,—

*Filices;* in the main entirely resembling their modern representatives, and some of which may even be generically, though not specifically, identical with them.

*Lycopodiaceæ;* the same in their main characters as those now existing, and, though of higher specialization of stem, of greater stature, of different species, and perhaps also genera, from modern *Lycopodiaceæ*, yet identical with these in the structure of their reproductive organs and their contents, and in the minute anatomy of their tissues.

*Coniferæ.* The evidence of this Order is derived chiefly from the anatomical characters of the Dicotyledonous wood so abundantly found in the coal, and which seems to be identical in all important respects with the wood of modern genera of that Order, to which must be added the probability of *Trigonocarpon* and *Nœggerathia* being Gymnospermous, and allied to *Salisburia*.* On the other hand, it must not be overlooked that no Coniferous strobili have been hitherto detected in the Carboniferous formation.

*Cycadeæ.* Some fragments of wood, presenting a striking similarity in anatomical characters to that of *Cycadeæ*, have been found in the carboniferous series.

In the absence of the fructification of *Calamites, Calamodendron, Halonia, Anabathra*, etc., there are no materials for any safe conclusions as to their immediate affinities, beyond that they all seem to be allied to Ferns or *Lycopodiaceæ;* but the same can hardly be said of the affinities of *Volkmannia*,† *Antholithes* and others, which have been referred, with more or less probability, to Angiospermous Dicotyledons.

The Permian Flora is for the most part specifically distinct from the Carboniferous, but many of

* Phil. Trans. 1855, p. 149.

† See Quarterly Journal of Geological Society, May, 1854.

its genera are the same. The prevalent types are Gymnospermous Dicotyledons, especially *Cycadeæ*, and a great abundance of Tree-ferns.

The New Red Sandstone, or Trias group, presents plants more analogous to those of the Oolite than to those of the Carboniferous epoch, but they have also much in common with the latter. *Voltzia*, a remarkable genus of Conifers, appears to be peculiar to this period.

In the Lias numerous species of *Cycadeæ* have been found, with various Conifers and many Ferns. No other Dicotyledonous or any Monocotyledonous plants have as yet been discovered, but it is difficult to believe that none such should have existed at a period when wood-boring and herb-devouring insects, belonging to modern genera, were extremely abundant, as has been proved by the researches of Mr. Brodie and Mr. Westwood.*

The Oolite contains numerous *Cycadeæ*, *Coniferæ*, and Ferns, and more herbivorous genera of insects; and here Monocotyledonous vegetables are recognizable in *Podocarya* and other Pandaneous plants. A cone of *Pinus* has been discovered in the Purbeck, and one of *Araucaria* in the inferior Oolite of Somersetshire.

In the Cretaceous group, Dicotyledons of a very high type appear. A good many species are enumerated† by Dr. Debey, of Aix-la-Chapelle, including a species of *Juglans*, a genus belonging to an Order of highly-developed floral structure and complex affinities.‡

*Characeæ* appear for the first time at this epoch, and are apparently wholly similar in structure to those of the present day.

The Tertiary strata present large assemblages of plants of so many existing Genera and Orders, that it can hardly be doubted but that even the earliest Flora of that period was almost as complex and varied as that of our own. In the lowest Eocene beds are found *Anonaceæ*, *Nipa*, *Acacia*, and *Cucurbitaceæ*.§ In the Bagshot sands some silicified wood has been found, which may confidently be referred to *Banksia*, and which is, in fact, scarcely distinguishable from recent and fossil Australian Banksia wood.‖

* These insects include species of the existing common European genera, *Elater*, *Gryllus*, *Hemerobius*, *Ephemera*, *Libellula*, *Panorpa*, and *Carabus*. Of all conspicuous tribes of plants the *Cycadeæ*, *Filices*, *Coniferæ*, and *Lycopodiaceæ* perhaps support the fewest insects, and the association of the above-named insects with a vegetation consisting solely or mainly of plants of these Orders is quite inconceivable.

† Quart. Journ. Geol. Soc. vii. pt. 1. misc. p. 110.

‡ Professor Oswald Heer, of Zurich, in an interesting little paper (Quelques Mots sur les Noyers), in Bibl. Univ. Genev. Sep. 1858, argues from the fact of the early appearance of *Juglans* in the geological series, that this genus must be a low type of the Dicotyledonous class to which it belongs. The position of *Juglans* is unsettled in the present state of our classification of Dicotyledonous Orders, as it has equal claims to be ranked with *Terebinthaceæ*, which are very high in the series, and with *Cupuliferæ*, which are placed very low; and were the grounds for our thus ranking these Orders based on characters of ascertained relative value, such an argument might be admissible; but the system which sunders these Orders is a purely artificial one, and *Juglans* with its allies would prove it so, if other proofs were wanting; for it absolutely combines *Terebinthaceæ* and *Cupuliferæ* into one natural group, in which (as in so many others) there is a gradual passage from great complexity of floral organs to great simplicity.

§ I am far from considering the identification of these and the other genera which I have enumerated in various strata as satisfactory, but I conclude that they may be taken as evidence of as highly developed and varied plants having then existed as are now represented by these genera.

‖ I am indebted to the late Robert Brown for this fact, and for the means of comparing the specimens, which are beautifully opalized. I ascertained that he was satisfied with the evidence of this wood having really been dug up near Staines, though it is so perfectly similar in every respect to the opalized Banksia-wood of Tasmania as to suggest to his mind and my own the most serious doubts as to its English origin.

In the brown coal of the Eocene and Miocene periods, Fan-palms, Conifers, and various existing genera of *Myriceæ*, *Laurineæ*, and *Plataneæ* are believed to have been identified. Wesel and Weber describe from the brown coal of the Rhine a rich and varied Flora, representing numerous families never now seen associated, and including some of the peculiar and characteristic genera of the Australian, South African, American, Indian, and European Floras.*

In the Mollasse and certain Miocene formations at Œningen and elsewhere in Germany, Switzerland, and Tuscany,† 900 species of Dicotyledons‡ have been observed, all apparently different from existing ones. They have been referred, with more or less probability, to Fan-palms, Poplars (three species), evergreen *Laurineæ*, *Ceratonia*, *Acacia*, *Tamarindus*, *Banksia*, *Embothrium*, *Grevillea*, *Cupressus*, several species of *Juglans* (one near the North-American *J. acuminata*, another near the common Walnut of Europe and Asia, *J. nigra*, and a third near the North-American *J. cinerea*); also a Hickory, near the *Carya alba* (a genus now wholly American), and a *Pterocarya* closely allied to *P. Caucasica*.

The rise of the Alps was subsequent to this period; and in the European deposits immediately succeeding that event, in Switzerland (at Durnten and Utznach) are found evidences of the following existing species,—Spruce, Larch, Scotch Fir, Birch, a Hazel (different from that now existing), *Scirpus lacustris*, *Phragmites communis*, and *Menyanthes trifoliata*.

The glacial epoch followed, during and since which there has probably been little generic change in the vegetation of the globe.

32. So much for the main facts hitherto regarded as established in Vegetable Palæontology; they are of little value as compared with those afforded by the Animal Kingdom, even granting that they are all well made out, which is by no means the case. In applying them theoretically to the solution of the question of creation and distribution, the first point which strikes us is the impossibility of establishing a parallel between the successive appearances of vegetable forms in time, and their complexity of structure or specialization of organs, as represented by the successively higher groups in the Natural method of classification. Secondly, that the earliest recognizable Cryptogams

* See Quart. Journ. Geol. Soc. xv. misc. 3, where an abstract is given, with some excellent cautions, by C. J. F. Bunbury, Esq. The Australian genera include *Eucalyptus*, *Casuarina*, *Leptomeria*, *Templetonia*, *Banksia*, *Dryandra*, and *Hakea*. I am not prepared to assert that these identifications, or the Australian ones of the Mollasse, are all so unsatisfactory that the evidence of Australian types in the brown coal and Mollasse should be altogether set aside; but I do consider that not one of the above-named genera is identified at all satisfactorily, and that many of them are not even problematically decided.

† During the printing of this sheet I have received from my friend M. De Candolle a very interesting memoir on the tertiary fossil plants of Tuscany, by M. C. Gaudin and the Marquis C. Strozzi, in which some of the genera here alluded to are described. The age of these Tuscan beds is referred by Prof. O. Heer to a period intermediate between those of Utznach and Œningen. The most important plants described are, Coniferæ, 6 sp.; Salix, 2; Liquidambar, 1; Alnus, 1; Carpinus, 1; Populus, 2; Fagus, 1; Quercus, 5; Ulmus, 2; Planera, 1; Ficus, 1; Platanus, 1; Oreodaphne, 1; Laurus, 2; Persea, 1; Acer, 2; Vitis, 1; Juglans, 4; Carya, 1; Pterocarya, 1. There are 49 extinct species in all, of which 46 are referred, without even a mark of doubt or caution, to existing genera, and this in almost all cases from imperfect leaves alone! Without questioning the good faith or ability of the authors of this really valuable and interesting memoir, I cannot withhold my protest against this practice of making what are at best little better than surmises, appear under the guise of scientifically established identifications. What confidence can be placed in the positive reference of supposed fossil Fungi to *Sphæria*, or of pinnated leaves to *Sapindus*, and other fragments of foliage to existing genera of *Laurineæ*, *Ficus*, and *Vitis?*

‡ O. Heer, Sur les Charbons feuilletés de Durnten et Utznach, in Mem. Soc. Helvet. Sc. Nat. 1857; Bibl. Univers. Genev. August, 1858.

should not only be the highest now existing, but have more highly differentiated vegetative organs than any subsequently appearing; and that the dicotyledonous embryo and perfect exogenous wood with the highest specialized tissue known (the coniferous, with glandular tissue*), should have preceded the monocotyledonous embryo and endogenous wood in date of appearance on the globe, are facts wholly opposed to the doctrine of progression, and they can only be set aside on the supposition that they are fragmentary evidence of a time further removed from that of the origin of vegetation than from the present day; to which must be added the supposition that types of *Lycopodiaceæ*, and a number of other Orders and Genera, as low as those now living, existed at that time also.

Another point is the evidence,† said to be established, of genera now respectively considered peculiar to the five continents having existed cotemporaneously at a comparatively recent geological epoch in Europe, and the very close affinity, if not identity, of some of these with existing species. The changes in the level and contour of the different parts of the earth's surface which have occurred since the period of the chalk, or even since that preceding the rise of the Alps, imply a very great amount of difference between the past and present relations of sea and land and climate; and it is no doubt owing to these changes that the *Araucariæ*, which once inhabited England, are no longer found in the northern hemisphere, and that the Australian genera which inhabited Europe at a period preceding the rise of the Alps have since been expelled.

Such facts, standing at the threshold of our knowledge of vegetable palæontology, should lead us to expect that the problem of distribution is an infinitely complicated one, and suggest the idea that the mutations of the surface of our planet, which replace continents by oceans, and plains by mountains, may be insignificant measures of time when compared with the duration of some existing genera and perhaps species of plants, for some of these appear to have outlived the slow submersion of continents.

35. From the sum then of our theories, as arranged in accordance with ascertained facts, we may make the following assumptions:—That the principal recognized families of plants which inhabited the globe at and since the Palæozoic period still exist, and therefore have as families survived all intervening geological changes. That of these types some have been transferred, or have migrated, from one hemisphere to another. That it is not unreasonable to suppose that further evidence may be forthcoming which will show that all existing species may have descended genealogically from fewer pre-existing ones; that we owe their different forms to the variation of individuals, and the power of limiting them into genera and species to the destruction of some of these varieties, etc., and the increase in individuals of others. Lastly, that the fact of species being with so much uniformity the ultimate and most definable group (the leaves as it were of the family tree), may possibly be owing to the tendency to vary being checked, partly by the ample opportunities each brood of a

* The vexed question of the true position of Gymnospermous plants in the Natural System assumes a somewhat different aspect under the view of species being created by progressive evolution. In the haste to press the recent important discoveries in vegetable impregnation and embryogeny into the service of classification, the long-established facts regarding the development of the stem, flower, and reproductive organs themselves of Gymnospermous plants have been relatively underrated or wholly lost sight of; and if an examination of the doctrines of progression and variation lead to a better general estimation of the comparative value of the characters presented by these organs, the acceptance or rejection of the doctrines themselves is, in the present state of science, a matter of secondary importance.

† See first foot-note of p. xxi (*): what I have there said of the supposed identifications of the Australian genera applies to many of those of the other enumerated quarters of the globe.

variety possesses of being fertilized by the pollen of its nearest counterpart, partly by the temporary stability of its surrounding physical conditions, and partly by the superabundance of seeds shed by each individual, those only vegetating which are well suited to existing conditions: an appearance of stability is also, in the case of many perennials, due to the fact that the individuals normally attain a great age,* and thus survive many generations of other species, of which generations some present characters foreign to their parents.

36. In the above line of argument I have not alluded to the question of the origin of those families of plants which appear in the earliest geological formations, nor to that of vegetable life in the abstract, conceiving these to be subjects upon which, in the present state of science, botany throws no light whatever. Regarded from the classificatory point of view, the geological history of plants is not altogether favourable to the theory of progressive development, both because the earliest ascertained types are of such high and complex organization,† and because there are no known fossil plants which we can certainly assume to belong to a non-existing class or even family, nor that are ascertained to be intermediate in affinity between recent classes or families.‡

The progress of investigation may ultimately reveal the true history of the unrecognized vegetable remains with which our collections abound, and may discover to us amongst them new and unexpected organisms, suggesting or proving a progressive development; but in the meantime the fact remains that the prominent phenomena of vegetable palæontology do not advance us one step towards a satisfactory conception of the first origin of existing Natural Orders of plants.

Taking the Conifers as an example, whatever rank is given to them by the systematist, that they should have preceded Monocotyledons and many Dicotyledons in date of appearance on the globe, is a fact quite incompatible with progressive development in the scientific acceptation of the term, whilst to argue from their apparently early appearance that they are low in a classificatory system is begging the question.

Another fact to be borne in mind is, that we have no accurate idea of what systematic progression is in botany. We know little of high and low in the Vegetable Kingdom further than is expressed by the sequence of the three classes, Dicotyledons, Monocotyledons, and Acotyledons; and amongst Acotyledons, of Thallogens being lower than Acrogens, and of these that the Mosses, etc., are lower than Filices and their allies. It is true that we technically consider multiplication and complexity of floral whorls in phænogamic plants as indications of superior organization; but very many

* In considering the relative amount and rate at which different plants vary, it should be remembered that we habitually estimate them not only loosely but falsely. We assume annuals to be more variable than perennials, but we probably greatly overrate the amount to which they really are so, because a brief personal experience enables us to study many generations of an annual under many combinations of physical conditions; whereas the same experience embraces but a fractional period of the duration of (comparatively) very few perennials. It has also been well shown by Bentham (in his paper on the British Flora, read (1858) before the Linnæan Society) that an appearance of stability is given to many varieties of perennials, through their habitual increase by buds, offsets, etc., which propagate the individual; and in the case of *Rubi*, which comparatively seldom propagate by seed, a large tract of ground may be peopled by parts of a single individual.

† I have elsewhere stated that I consider the evidence of *Algæ* having existed at a period preceding vascular Cryptogams to be of very little value. (Lond. Journ. Bot. viii. p. 254.)

‡ It must not be supposed that in saying this I am even expressing a doubt as to there having been plants intermediate in affinity between existing Orders and Classes. Analogy with the animal kingdom suggests that some at any rate of the plants of the coal epoch do hold such a relationship; but should they not do so, I consider this fact to be of little value in the present inquiry, for I incline to believe that the ascertained geological history of plants embraces a mere fraction of their whole history.

of the Genera and Orders most deficient in these respects are so manifestly reduced members of others, which are indisputably the most complex in organization in the whole Vegetable Kingdom, that no good classification even has been founded on these considerations alone.*

37. Again, it is argued by both Mr. Darwin and Mr. Wallace that the general effects of variation by selection must be to establish a general progressive development of the whole animal kingdom. But here again in botany we are checked by the question, What is the standard of progression? Is it physiological or morphological? Is it evidenced by the power of overcoming physical obstacles to dispersion or propagation, or by a nice adaptation of structure or constitution to very restricted or complex conditions? Are cosmopolites to be regarded as superior to plants of restricted range, hermaphrodite plants to unisexual, parasites to self-sustainers, albuminous-seeded to exalbuminous, gymnosperms to angiosperms, water plants to land, trees to herbs, perennials to annuals, insular plants to continental? and, in fine, what is the significance of the multitudinous differences in point of structure and complexity, and powers of endurance, presented by the members of the Vegetable Kingdom, and which have no recognized physiological end and interpretation, nor importance in a classificatory point of view? It is extremely easy to answer any of these questions, and to support the opinion by a host of arguments, morphological, physiological, and teleological; but any one gifted with a quick perception of relations, and whose mind is stored with a sufficiency of facts, will turn every argument to equal advantage for both sides of the question.

To my mind, however, the doctrine of progression, if considered in connection with the hypothesis of the origin of species being by variation, is by far the most profound of all that have ever agitated the schools of Natural History, and I do not think that it has yet been treated in the unprejudiced spirit it demands. The elements for its study are the vastest and most complicated which the naturalist can contemplate, and reside in the comprehension of the reciprocal action of the so-called inorganic on the organic world. Granting that multiplication and specialization of organs is the evidence and measure of progression, that variation explains the *rationale* of the operation which results in this progression, the question arises, What are the limits to the combinations of physical causes which determine this progression, and how can the specializing power of Nature stop short of causing every race or family ultimately to represent a species? While the psychological philosophers persuade us that we see the tendency to specialize pervading every attribute of organic life, mental and physical; and the physicists teach that there are limits to the amount and duration of heat, light, and every other manifestation of physical force which our senses present or our intellects perceive, and which are all in process of consumption; the reflecting botanist, knowing that his ultimate results must accord with these facts, is perplexed at feeling that he has failed to establish on independent evidence the doctrines of variation and progressive specialization, or to co-ordinate his attempts to do so with the successive discoveries in physical science.

* The subject of the retrogression of types has never yet been investigated in botany, nor its importance estimated in inquiries of this nature. To whatever Order we may grant the dignity of great superiority or complexity, we find that Order containing groups of species of very simple organization; these are moreover often of great size and importance, and of wide geographical distribution. Such groups, if regarded *per se*, appear to be far lower in organization than other groups which are many degrees below them in the classified series; and our only clue to their real position is their evident affinity with their complex co-ordinates;—destroy the latter by a geological or other event, and all clue to the real position of the former may be lost. Are such groups of simply-constructed species created by retrogressive variation of the higher, or did the higher proceed from them by progressive variation? If the latter, did the simpler forms precede in origin the highest forms of all other groups which rank below them in the classified series?

38. Before dismissing this subject, I may revert once more to the opposite doctrine, which regards species as immutable creations, and this principally to observe that the arguments in its favour have neither gained nor lost by increased facilities for investigation, or by additional means for observation. The facts are unassailable that we have no direct knowledge of the origin of any wild species; that many are separated by numerous structural peculiarities from all other plants; that some of them invariably propagate their like; and that a few have retained their characters unchanged under very different conditions and through geological epochs. Recent discoveries have not weakened the force of these facts, nor have successive thinkers derived new arguments from them; and if we hence conclude from them that species are really independent creations and immutable, though so often illimitable, then is all further inquiry a waste of time, and the question of their origin, and that of their classification in Genera and Orders, can, in the present state of science, never be answered, and the only known avenues to all means of investigation must be considered as closed till the origin of life itself is brought to light.

39. Of these facts the most important, and indeed the only one that affords a tangible argument, is that of genetic resemblance. To the tyro in Natural History all similar plants may have had one parent, but all dissimilar plants must have had dissimilar parents. Daily experience demonstrates the first position, but it takes years of observation to prove that the second is not always true. There are, further, certain circumstances connected with the pursuit of the sciences of observation which tend to narrow the observer's views of the attributes of species; he begins by examining a few individuals of many extremely different kinds or species, which are to him fixed ideas, and the relationships of which he only discovers by patient investigation; he then distributes them into Genera, Orders, and Classes, the process usually being that of reducing a great number of dissimilar ideas under a few successively higher general conceptions; whilst with the history of the ideas themselves, that is, of species, he seldom concerns himself. In a study so vast as botany, it takes a long time for a naturalist to arrive at an accurate knowledge of the relations of Genera and Orders if he aim at being a good systematist, or to acquire an intimate knowledge of species if he aim at a proficiency in local Floras, and in both these pursuits the abstract consideration of the species itself is generally lost sight of; the systematist seldom returns to it, and the local botanist, who finds the minutest differences to be hereditary in a limited area, applies the argument derived from genetic resemblance to every hereditarily distinct form.

40. It has been urged against the theory that existing species have arisen through the variation of pre-existing ones and the destruction of intermediate varieties, that it is a hasty inference from a few facts in the life of a few variable plants, and is therefore unworthy of confidence, if not of consideration; but it appears to me that the opposite theory, which demands an independent creative act for each species, is an equally hasty inference from a few negative facts in the life of certain species,* of which some generations have proved invariable within our extremely limited experience. These theories must not, however, be judged of solely by the force of the very few absolute facts on which they are based; there are other considerations to be taken into account, and especially the conclusions to which they lead, and their bearing upon collateral biological phenomena, under which points of view the theory of independent creations appears to me to be greatly at a disadvantage; for according to it every fact and every phenomenon regarding the origin and continuance of species, but that of their occasional variation, and their extinction by natural causes, and regarding the *rationale* of classi-

* See paragraph 4, where I have stated that the grand total of unstable species probably exceeds that of the stable.

fication, is swallowed up in the gigantic conception of a power intermittently exercised in the development, out of inorganic elements, of organisms the most bulky and complex as well as the most minute and simple; and the consanguinity of each new being to its pre-existent nearest ally, is a barren fact, of no scientific significance or further importance to the naturalist than that it enables him to classify. The realization of this conception is of course impossible; the boldest speculator cannot realize the idea of a highly organized plant or animal starting into life within an area that has been the field of his own exact observation* and research; whilst the more cautious advocate hesitates about admitting the origin of the simplest organism under such circumstances, because it compels his subscribing to the doctrine of the "spontaneous generation" of living beings of every degree of complexity in structure and refinement of organization.

On the other hand, the advocate of creation by variation may have to stretch his imagination to account for such gaps in a homogeneous system as will resolve its members into genera, classes, and orders; but in doing so he is only expanding the principle which both theorists allow to have operated in the resolution of some groups of individuals into varieties: and if, as I have endeavoured to show, all those attributes of organic life which are involved in the study of classification, representation, and distribution, and which are barren facts under the theory of special creations, may receive a rational explanation under another theory, it is to this latter that the naturalist should look for the means of penetrating the mystery which envelopes the history of species, holding himself ready to lay it down when it shall prove as useless for the further advance of science, as the long serviceable theory of special creations, founded on genetic resemblance, now appears to me to be.

The arguments deduced from genetic resemblance being (in the present state of science), as far as I can discover, exhausted, I have felt it my duty to re-examine the phenomena of variation in reference to the origin of existing species; these phenomena I have long studied independently of this question, and when treating either of whole Floras or of species, I have made it my constant aim to demonstrate how much more important and prevalent this element of variability is than is usually admitted, as also how deep it lies beneath the foundations of all our facts and reasonings concerning classification and distribution. I have hitherto endeavoured to keep my ideas upon variation in subjection to the hypothesis of species being immutable, both because a due regard to that theory checks any tendency to careless observation of minute facts, and because the opposite one is apt to lead to a precipitate conclusion that slight differences have no significance; whereas, though not of specific importance, they may be of high structural and physiological value, and hence reveal affinities that might otherwise escape us. I have already stated how greatly I am indebted to Mr. Darwin's† *rationale* of the phenomena of variation and natural selection in the production of species; and though it does not positively establish the doctrine of creation by variation, I expect that every additional fact and observation relating to species will gain great additional value from being viewed in reference to it, and that it will materially assist in developing the principles of classification and distribution.

* It is a curious fact (illustrative of a well-known tendency of the mind), that the few writers who have in imagination endeavoured to push the doctrine of special creations to a logical issue, either place the scene of the creative effort in some unknown, distant, or isolated corner of the globe, removed far beyond the ken of scientific observation, or suppose it to have been enacted at a period when the physical conditions of the globe differed both in degree and kind from what now obtain; thus in both cases arguing *ad ignotum ab ignoto*.

† In this Essay I refer to the brief abstract only (Linn. Journ.) of my friend's views, not to his work now in the press, a deliberate study of which may modify my opinion on some points whereon we differ. Matured conclusions on these subjects are very slowly developed.

# ON THE FLORA OF AUSTRALIA.

## § 1.

### *General Remarks.*

The Flora of Australia has been justly regarded as the most remarkable that is known, owing to the number of peculiar forms of vegetation which that continent presents. So numerous indeed are the peculiarities of this Flora, that it has been considered as differing fundamentally, or in almost all its attributes, from those of other lands; and speculations have been entertained that its origin is either referable to another period of the world's history from that in which the existing plants of other continents have been produced, or to a separate creative effort from that which contemporaneously peopled the rest of the globe with its existing vegetation; whilst others again have supposed that the climate or some other attribute of Australia has exerted an influence on its vegetation, differing both in kind and degree from that of other climates. One of my objects in undertaking a general survey of the Australian Flora, has been to test the value of the facts which have given rise to these speculations, and to determine the extent and comparative value of a different and larger class of facts which are opposed to them, and which might also give some clue to the origin of the Flora, and thus account for its peculiarities. This I pursued under the impression that it is the same with the study of whole Floras as of single species or their organs, viz. that it is much easier to see peculiarities than to appreciate resemblances, and that important general characters which pervade all the members of a family or Flora, are too often overlooked or undervalued, when associated with more conspicuous differences which enable us to dismember them. The result has proved, as I anticipated, that, the great difficulty being surmounted of collecting all the materials and so classifying them as to allow of their being generalized upon, the peculiarities of the Flora, great though they be, are found to be more apparent than real, and to be due to a multitude of specialities affecting the species, and to a certain extent the genera, but not extending to the more important characteristics of the vegetation, which is not fundamentally different from that of other parts of the globe.

Before proceeding to the discussion of the elements of the Australian Flora, I shall shortly describe its general character, viewed in the double light of a peculiar vegetation and as a part of the existing Flora of the globe. Its chief peculiarities are:—

That it contains more genera and species peculiar to its own area, and fewer plants belonging to other parts of the world, than any other country of equal extent. About two-fifths of its genera, and upwards of seven-eighths of its species are entirely confined to Australia.

Many of the plants have a very peculiar habit or physiognomy, giving in some cases a character to the forest scenery (as *Eucalypti, Acaciæ, Proteaceæ, Casuarinæ, Coniferæ*), or are themselves of anomalous or grotesque appearance (as *Xanthorrhœa, Kingia, Delabechea, Casuarina, Banksia, Dryandra,* etc.).

A great many of the species have anomalous organs, as the pitchers of *Cephalotus,* the deciduous bark and remarkable vertical leaves of the *Eucalypti,* the phyllodia of *Acacia,* the fleshy peduncle of *Exocarpus,* the inflorescence and ragged foliage of many *Proteaceæ.*

Many genera and species display singular structural peculiarities, as the ovules of *Banksia,* calyptra of *Eucalyptus,* stigma of *Goodeniaceæ,* staminal column of *Stylidium,* irritable labellum of various *Orchideæ,* flowers sunk in the wood of some *Leptospermeæ,* pericarp of *Casuarina,* receptacle and inner staminodia of *Eupomatia,* stomata of *Proteaceæ.*

On the other hand, if, disregarding the peculiarities of the Flora, I compare its elements with those of the Floras of similarly situated large areas of land, or with that of the whole globe, I find that there is so great an agreement between these, that it is impossible to regard Australian vegetation in any other light than as forming a peculiar, but not an aberrant or anomalous, botanical province of the existing Vegetable Kingdom. I find :—

That the relative proportions of the great classes of Monocotyledons to Dicotyledons, of genera to orders, and of species to genera, are the same as those which prevail in other Floras of equal extent.

That the subclasses distinguished by a greater or less complexity of the floral envelopes, or their absence, as *Thalamifloræ, Calycifloræ, Corollifloræ,* etc., are also in the same relative proportions as prevail in other Floras.

That the proportion of Gymnospermous plants to other Dicotyledons is not increased.

That all the Australian Natural Orders, with only two small exceptions, are also found in other countries; that most of those most widely diffused in Australia are such as are also the most widely distributed over the globe; and that Australia wants no known Order of general distribution.

That the only two absolutely peculiar Natural Orders contain together only three genera, and very few species; they are, further, comparatively local in Australia, and are rather aberrant forms of existing natural families than well-marked isolated groups: *Brunoniaceæ* being intermediate between *Goodeniaceæ* and *Compositæ,* and *Tremandreæ* between *Polygaleæ* and *Buettneriaceæ.*

That the large Natural Orders and Genera, which, though not absolutely restricted to Australia, are there very abundant in species and rare elsewhere, and for which I shall hence adopt the term Australian, stand in very close relationship to groups of plants which are widely spread over the globe (as *Epacrideæ* to *Ericeæ, Goodeniaceæ* to *Campanulaceæ, Stylideæ* to *Lobeliaceæ, Casuarinæ* to *Myricæ*).

That these Australian Orders are exceedingly unequally distributed in Australia; that there is a greater specific difference between two quarters of Australia (south-eastern and south-western) than between Australia and the rest of the globe; and that the most marked characteristics of the Flora are concentrated at that point which is geographically most remote from any other region of the globe.

That most of those Australian Orders and genera which are found in other countries around Australia, have their maximum development in Australia at points approximating in geographical position towards those neighbouring countries. Thus the peculiarly Indian features of the Flora are most developed in north-western Australia, the Polynesian and Malayan in north-eastern, the New Zealand and South American in south-eastern, and the South African in south-western Australia.

That of the nine largest Natural Orders, which together include a moiety of the Australian species of flowering plants, no fewer than six belong to the nine largest Natural Orders of the whole world, and five belong to the largest in India also.

That in Australia itself, in advancing from the tropics to the coldest latitudes, or from the driest to the most humid districts, or from the interior to the seashore, or in ascending the mountains, the changes in vegetation are in every aspect analogous to what occur in other parts of the globe.

That the relations between the epochs of the flowering and the fruiting of plants, and the seasons of the year, are the same in Australia as elsewhere, and most remarkably so, the *Orchideæ* being spring flowers, the *Leguminosæ* summer, the *Compositæ* autumn, and the *Cryptogamia* winter.

That the peculiarities of the Australian Flora in no way disturb the principles of natural arrangement derived from the study of the Flora of the globe apart from that of Australia; for after having attempted to consider the Australian vegetation in a classificatory point of view, shutting out of my view, as far as I could, that of other countries, I have been led to the conclusion that the authors of the Natural System—Ray, Linnæus,* and the Jussieus—might have developed the same Natural System had they worked upon Australian plants instead of upon European.

I find further, that the classes, orders, genera, and species, may be about as well (or as ill) fixed or limited by a study of their Australian members as by those of any other country similarly circumstanced, and that there is the same vagueness as to the exact limits of natural groups, a similar inequality amongst them in numerical value and botanical characters, and an analogous difficulty in forming subclasses intermediate between classes and orders, as other Floras present. The Australian Flora, in short, neither breaks down nor improves the Natural System of plants as a whole, though it throws great light on its parts; the Australian genera fall into their places in that system well enough, though that system was developed before Australia was known botanically, and was chiefly founded upon a study of the vegetation of its antipodes.

Thus, whether the Australian Flora is viewed under the aspect of its morphology and structure, as exhibited by its natural classification, or its numerical proportions or geographical distribution, it presents essentially the same primary features as do those of the other great continents: and it hence appears to me rash to assume that its origin belongs to another epoch of the earth's history than that of other Floras, when the proportions of its classes, etc., are identically the same with these; or that it should be attributed to a distinct creative effort, if this is manifested only in effecting morphological differences requisite to constitute species and genera in our classification, without disturbing the proportions of these; or that the local influence of the Australian climate should be essentially different from that of other countries, and yet effect no physiological change in the periods of flowering and fruiting, or produce any other functional disturbances of the vegetable organisms, or affect the agency of humidity, temperature, soil, and elevation, on plants.

I shall now take the Australian Flora in greater detail, and dwell more at length upon those features from which I have derived the above conclusions.

* The real merits of Linnæus as a founder of the Natural System have never been appreciated. In the well deserved admiration of the genius and labours of the Jussieus, it is forgotten that the powers displayed by Linnæus in constructing the Genera Plantarum was not less (perhaps greater) than that exercised in grouping these into those genera of a higher value, which are now called Jussieuan Orders. The history of our Natural System presents but four salient points:—I. Ray's division of all plants into Phænogams and Cryptogams, and of the former into Monocotyledons and Dicotyledons. II. Linnæus's forming natural groups called Genera, and rendering a knowledge of them accessible to scientific minds by means of a binomial nomenclature and a mixed natural and artificial system of Classes and Orders. III. The Jussieus' combining most of the genera of Linnæus into truly Natural Orders, under Ray's classes, which classes they divided into subclasses as artificial as many of Linnæus's classes were. IV. The separation of Gymnosperms, by Brown, which is the first step towards a natural classification of the Jussieuan Orders of Dicotyledons. (See Lond. Journ. of Bot. and Kew Gard. Misc. ix. 314 *note.*)

## § 2.

### *Estimate of the Australian Flora, and some General Remarks on the Classes and Orders, their Numbers, Distribution, and Affinity.*

I estimate the Flowering Plants known to be indigenous to Australia* at about 8,000 species, a number which will not in all probability be much increased by further investigations, because it includes upwards of 500 of which I have seen no specimens, and a considerable proportion of which will no doubt prove to be founded on error, and it includes a much larger number which I have reason to believe will prove to be varieties,† when more of their forms are collected, or themselves more carefully studied.

About ten years ago (1849), Brown, in the appendix to Sturt's Voyage, estimated the Australian Flora at something under 7,000 species; since which period 1,000 species have not been added, although the explored area has been greatly enlarged, both by surveys of the tropical coasts, and inland journeys made to the north of the Tropic of Capricorn, and especially by the investigations of Dr. Mueller, during his adventurous explorings of the Australian Alps, and of the northern and eastern parts. Dr. Mueller ‡ himself, who has personally explored more of the continent than any other botanist, except the late Allan Cunningham, considers that the total Flora, including the undiscovered species, Phænogamic and Cryptogamic (exclusive of the minute *Fungi* and fresh-water *Algæ*), cannot exceed 10,000 species. Cryptogamic plants are known to be extremely rare in Australia as compared with Phænogamic; nevertheless, as they already amount to fully 2,000 discovered species,§ I suspect that Dr. Mueller's estimate is more probably too low than too high, and that we may assume 9,000–10,000 flowering plants as an approximation to the number that will eventually be found to be indigenous to Australia.||

Considering that the vegetation of Australia is confined to a belt of more or less fertile land surrounding an arid desert, which occupies perhaps two-thirds of its total area, and that the tropical region is an extremely poor one in plants, this Flora must be considered as very large. And if the tropical Flora is excluded, and the temperate alone compared numerically with that of Europe for instance, the very varied nature of the Australian vegetation will appear all the more remarkable. Thus the superficies clothed with any considerable number of species in extra-tropical Australia, is probably not equal to one-fifth of the similarly clothed area of Europe, which, though so much more varied in all its physical features, contains only 9,648** species, according to Nyman's list, and this

* Except when otherwise stated, I include Tasmania and its islands under the general term Australia.

† Dr. Mueller's valuable notes upon my 'Tasmanian Flora,' which will be found in the Supplement, show how very much is to be done in the reduction of species founded on herbarium specimens, even when these are unusually copious and good.

‡ Journal of the Linnæan Society, Botany, vol. ii. p. 141.

§ In Tasmania alone there are Ferns and allies, 70; Mosses and Hepaticæ, 386; Algæ, 315; Lichens, about 100; Fungi, 275. And I cannot doubt but that this number will be doubled by future discoverers.

|| I need hardly remark, that the very different opinions entertained by botanists as to what amount and constancy of difference between many forms of plants should constitute a species, renders all such comparisons vague; and I may add that no two or more botanists can ascertain the comparative value of their opinions except they have *exactly* the same materials to work with. It is too often forgotten that in the sciences of observation what are called negative facts and evidence are worthless as compared with positive.

** Nyman, Sylloge Floræ Europæ.

includes a large proportion of what would be considered varieties in all the Australian estimates. To be more precise, I may state, that the fertile portions of the colonies of New South Wales, Victoria, South Australia, and Western Australia, do not probably, in the aggregate, exceed in area Spain, Italy, Greece, and European Turkey, and contain perhaps half as many more flowering plants, or as many as these European countries together with Asia Minor and the Caucasus do. There is, however, little or nothing to be learnt from such numerical comparisons of species, when not examined in relation to the generic and ordinal differences which characterize them, and to which I shall hereafter allude.

The relative proportions of the two great classes of Flowering plants, Monocotyledons to Dicotyledons, are as 1 : 4·6,* which is a close approximation to what is supposed to obtain in the vegetation of the whole globe (1 : 4·9),† a remarkable coincidence, when the fact I have already alluded to is borne in mind, that seven-eighths of the species, and two-fifths of the genera of Australia have not been found elsewhere on the globe.

Regarding the temperate and tropical Australian Floras separately, I find that the tropical contains about 2,200 species, and the temperate 5,800, and that the proportions of Monocotyledons to Dicotyledons in each are,—

| | | | |
|---|---|---|---|
| Tropical Flora . . . | 1 : 3·5 | Temperate Flora . . . | 1 : 5·0 |

Comparing these numbers with those obtained from similarly large areas, there is again a remarkable concordance,‡ exemplifying the established fact that the proportion of Dicotyledons increases with the increasing distance from the tropics. Thus we have,—

| *Temperate Floras.* | | | | *Tropical Floras.* | | | |
|---|---|---|---|---|---|---|---|
| Europe[1] . . . . . | Monocot. : | Dicot. :: | 1 : 5·2 | Western Trop. Africa[5] | Monocot. : | Dicot. :: | 1 : 3·6 |
| Russian Empire[2] . . | „ | „ | 1 : 5·1 | Ceylon[6] . . . . . | „ | „ | 1 : 3·1 |
| British North America[3] | „ | „ | 1 : 3·8 | India[7] . . . . . | „ | „ | 1 : 3·8 |
| South Africa[4] . . . | „ | „ | 1 : 4·2 | Tropics[8] generally . | „ | „ | 1 : 3·0 |
| Australia . . . . | „ | „ | 1 : 5·0 | Australia . . . . | „ | „ | 1 : 3·5 |

* Brown (General Remarks, p. 6) gives the proportion of Dicotyledons to Monocotyledons as rather more than 3 : 1, from which it appears that the results of subsequent collections has been to increase the number of Dicotyledons relatively to that of Monocotyledons very largely. And this is as was to be expected, for the Monocotyledons are most widely diffused, and hence tend to preponderate unduly in incomplete Floras.

† According to Lindley's 'Vegetable Kingdom,' in which the numerical values of the Orders, as regards the genera and species they contain, were obtained with great labour, and are entitled to much confidence.

‡ Brown, on the contrary (Gen. Remark ), found a considerable discordance on this very point, for his materials from New South Wales and from King George's Sound both gave the proportion of Monocotyledons to Dicotyledons as very nearly 1 : 3, and his Tropical Flora the same. He adds :—" I confess I can perceive nothing, either in the nature of the soil or climate of Terra Australis, or in the circumstances under which our collections were formed, to account for the remarkable exceptions to the general proportions of the two classes in the corresponding latitudes of other countries."

I have satisfied myself, by a comparison of the relative distribution of Monocotyledons and Dicotyledons within Australia, that this discordance was only apparent, and due to the fact of his collections not being complete enough. I have elsewhere remarked that the same source of error has vitiated Brown's estimates of the proportions of the classes in Western Africa (Linn. Trans. xx. p. 240 *note*).

1 Nyman, Sylloge.
3 Hooker's 'Flora Boreali-Americana.'
5 Hooker's 'Niger Flora.'
2 Ledebour, 'Flora Rossica.'
4 Drége, Meyer, Harvey's MSS., etc.
6 Thwaites's 'Summary.'
7 Author's MSS. The Indian Flora here estimated includes a large number of temperate and alpine plants, and the proportion of Dicotyledons is hence high.
8 A. De Candolle, Geogr. Bot. p. 1188.

The Gymnospermous Dicotyledons being regarded by many botanists as a class equivalent in rank with all Angiospermous Phænogams, and all the Australian species being endemic, I have thought it might be interesting approximately to compare their proportions to other Phænogams. They are,—

| | |
|---|---|
| In Australia | 1 : 184 |
| In Europe | 1 : 194 |
| In the Russian Empire | 1 : 160 |
| In India | 1 : 292 |
| In the whole world | 1 : 315 |

I may remark, that in selecting Floras for comparing the proportions of Orders, it is necessary to take such as embrace a very large area, and are moreover tolerably well defined as botanical provinces. Of those I have compared, India is inapplicable, being a heterogeneous assemblage of temperate, tropical, and alpine plants, the tropical being however so far dominant as to determine the main results. Ceylon, again, is both far too small as an area, and is not a botanical province; the proportions of the Indian Orders in it are, however, on the whole, so well balanced, that it gives normal results.

The number of Natural Orders of Phænogamic plants in Australia is about 152.* Of these none are absolutely peculiar except *Brunoniaceæ* and *Tremandreæ*, which may without violence be respectively appended to *Goodeniaceæ* and *Buettneriaceæ*. Of about fifty absent Orders, the following are universally recognized as large and tropical Indian, and their total absence in Australia is certainly anomalous; *Ternstrœmiaceæ* (if *Cochlospermum* be excluded), *Dipterocarpeæ*, *Guttiferæ* (exclusive of *Calophyllum*), *Ochnaceæ*, *Connaraceæ*, *Balsamineæ*, *Begoniaceæ*, *Vaccinieæ*.

The following are also tropical Indian, but are small; some of them are not universally recognized, but are appended by various authors to other Orders which do exist in Australia:—

Samydeæ: a family of *Bixaceæ*.
Tamariscineæ.
Myriceæ: of which *Casuarineæ* are possibly a family.
Pyrenacantheæ: referred to *Antidesmeæ* or *Euphorbieæ*.

The following are temperate Orders, found elsewhere in the southern hemisphere, but not in Australia:—

Fumariaceæ: a Suborder of *Papaveraceæ*.
Salicineæ: almost entirely a northern Order.
Berberideæ: ditto, except in the South American Andes.
Valerianeæ: ditto, except in the South American Andes.

The Orders which, without being absolutely confined to Australia, are either peculiarly characteristic of that country, or are almost entirely confined to it, are either very small indeed, or are sections of larger Orders, as,—

* The following estimates are founded on the assumption that there are about 200 Natural Orders in all the Vegetable Kingdom, that is to say, so many Natural groups which are—1. Types of structure common in most cases to a large number of species, and containing several or many Genera; 2. Groups absolutely definable by natural characters, or betraying a transition to other groups by only a small proportion of their species. My views on these points accord with those of Bentham (Linn. Soc. Journ. Bot. vii. p. 31) and Asa Gray, who also consider 200 as a fair approximate estimate of the known Natural Orders.

Stackhousiæ: containing only about 20 species, and of which representatives are found in New Zealand and the Philippine Islands.
Goodeniaceæ: very closely allied to *Campanulaceæ* and *Lobeliaceæ*.
Stylidieæ: ditto.
Epacrideæ: a division of *Ericeæ*.
Casuarineæ: very near *Myriceæ*.
Xerotideæ } sections of *Liliaceæ* or *Junceæ*.
Aphyllantheæ }

Other Orders which are less peculiar but are largely developed and equally or more characteristic of Australian vegetation than the other, are:

| | | | |
|---|---|---|---|
| Dilleniaceæ, | after Australia, | abound most in | India. |
| Rutaceæ | ,, | ,, | South Africa. |
| Proteaceæ | ,, | ,, | Ditto. |
| Restiaceæ | ,, | ,, | Ditto. |
| Thymeleæ | ,, | ,, | Ditto. |
| Hæmodoraceæ | ,, | ,, | Ditto. |
| Buettneriaceæ | ,, | ,, | Ditto. |
| Droseraceæ | ,, | ,, | Ditto. |

Turning again to other countries which are remarkable for the peculiarity of their vegetation, I find that South America contains many more peculiar families than Australia, and South Africa about as many.

## § 3.

### *On the Australian Distribution of Natural Orders.*

I have attempted in various ways so to group the Orders as to show the geographical distribution of the characteristic ones; of these I shall select the following as illustrating most clearly, both that the temperate Flora is more peculiar than the tropical, and that that quarter of the continent which is geographically most isolated contains the greatest number of peculiar features.

A. Orders which are most characteristic of Australia, and almost confined to it:—

| | | | | | | |
|---|---|---|---|---|---|---|
| 1. Stackhousieæ | *has most species in the* | South-west; | *next,* | South-east; | *fewest in the* | Tropics. |
| 2. Goodeniaceæ | ,, | South-west | ,, | South-east | ,, | Tropics. |
| 3. Stylidieæ | ,, | South-west | ,, | South-east | ,, | Tropics. |
| 4. Epacrideæ | ,, | South-east | ,, | South-west | ,, | Tropics. |
| 5. Tremandreæ | ,, | South-west | ,, | South-east | ,, | Tropics. |
| 6. Casuarineæ | ,, | South-west | ,, | South-east | ,, | Tropics. |
| 7. Xerotideæ | ,, | South-west | ,, | South-east | ,, | Tropics. |

| | | | |
|---|---|---|---|
| Hence, Six-sevenths | attain their | maximum in the | South-west. |
| One-seventh | ,, | ,, | South-east. |
| None | ,, | ,, | Tropics. |

B. Orders which attain their maximum in Australia, and most of the Australian genera and species of which are peculiar to that country:—

*f*

| | | | | | | |
|---|---|---|---|---|---|---|
| 1. Proteaceæ | *has most species in the* | South-west; | *next,* | South-east; | *fewest in the* | Tropics. |
| 2. Dilleniaceæ | „ | South-west | „ | South-east | „ | Tropics. |
| 3. Droseraceæ | „ | South-west | „ | South-east | „ | Tropics. |
| 4. Myoporineæ | „ | South-west | „ | South-east | „ | Tropics. |
| 5. Rutaceæ | „ | South-east | „ | South-west | „ | Tropics. |
| 6. Halorageæ | „ | South-east | „ | South-west | „ | Tropics. |
| 7. Pittosporeæ | „ | South-west | „ | South-east | „ | Tropics. |
| 8. Thymeleæ | „ | South-east | „ | South-west | „ | Tropics. |
| 9. Hæmodoraceæ | „ | South-west | „ | South-east | „ | Tropics. |
| 10. Restiaceæ | „ | South-west | „ | South-east | „ | Tropics. |

Here again, Seven-tenths attain their maximum in the South-west.
Three-tenths „ „ South-east.
None „ „ Tropics.

C. Orders which are not at all peculiar to Australia, and do not there attain their maximum, but of which more than half the species are peculiar, and many belong to peculiar Australian genera:—

| | | | | | | |
|---|---|---|---|---|---|---|
| 1. Leguminosæ | *has most species in the* | South-east; | *next,* | South-west; | *fewest in the* | Tropics. |
| 2. Myrtaceæ | „ | South-west | „ | South-east | „ | Tropics. |
| 3. Compositæ | „ | South-east | „ | South-west | „ | Tropics. |
| 4. Umbelliferæ | „ | South-east | „ | South-west | „ | Tropics. |
| 5. Irideæ | „ | South-west | „ | South-east | „ | Tropics. |
| 6. Melanthaceæ | „ | South-east | „ | South-west | „ | Tropics. |
| 7. Santalaceæ | „ | South-west | „ | South-east | „ | Tropics. |
| 8. Phytolacceæ | „ | South-west | „ | South-east | „ | Tropics. |
| 9. Saxifrageæ | „ | South-east | „ | South-west | „ | Tropics. |

This gives Five-ninths attaining their maximum in the South-east.
Four-ninths „ „ South-west.
None „ „ Tropics.

D. Orders, all containing upwards of thirty species, but of which comparatively few, or none, of the genera are peculiar.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1. Gramineæ | *has most species in the* | Tropics; | *next,* | South-east; | *fewest in the* | South-west. |
| 2. Cyperaceæ | „ | South-west | „ | South-east | „ | Tropics. |
| 3. Orchideæ | „ | South-east | „ | South-west | „ | Tropics. |
| 4. Euphorbiaceæ | „ | Tropics | „ | South-east | „ | South-west. |
| 5. Labiatæ | „ | South-east | „ | South-west | „ | Tropics. |
| 6. Liliaceæ | „ | South-east | „ | South-west | „ | Tropics. |
| 7. Rubiaceæ | „ | Tropics | „ | South-east | „ | South-west. |
| 8. Scrophularineæ | „ | Tropics | „ | South-east | „ | South-west. |
| 9. Amaranthaceæ | „ | South-west | „ | Tropics | „ | South-east. |
| 10. Chenopodiaceæ | „ | South-west | „ | South-east | „ | Tropics. |
| 11. Sapindaceæ | „ | Tropics | „ | South-west | „ | South-east. |
| 12. Malvaceæ | „ | Tropics | „ | South-east | „ | South-west. |
| 13. Convolvulaceæ | „ | Tropics | „ | South-east | „ | South-west. |
| 14. Rhamneæ | „ | Tropics | „ | South-west | „ | South-east. |

| | | | | | | |
|---|---|---|---|---|---|---|
| 15. Verbenaceæ | *has most species in the* | Tropics; | *next,* | South-west; | *fewest in the* | South-east. |
| 16. Loganiaceæ | ,, | Tropics | ,, | South-west | ,, | South-east. |
| 17. Cruciferæ | ,, | South-east | ,, | South-west | ,, | Tropics. |
| 18. Loranthaceæ | ,, | Tropics | ,, | South-east | ,, | South-west. |
| 19. Lobeliaceæ | ,, | South-west | ,, | South-east | ,, | Tropics. |
| 20. Urticeæ | ,, | Tropics | ,, | South-east | ,, | South-west. |
| 21. Ranunculaceæ | ,, | South-east | ,, | South-west | ,, | Tropics. |
| 22. Polygaleæ | ,, | South-west | ,, | South-east | ,, | Tropics. |
| 23. Solaneæ | ,, | Tropics | ,, | South-east | ,, | South-west. |
| 24. Lentibularineæ | ,, | South-east | ,, | South-west | ,, | Tropics. |
| 25. Boragineæ | ,, | Tropics | ,, | South-west | ,, | South-east. |

The sequence in this case is wholly inverted from what obtained in A and B, and we have—

| | | | |
|---|---|---|---|
| Fourteen twenty-fifths attaining their maximum in the Tropics. | | | |
| Six twenty-fifths | ,, | ,, | South-east. |
| Five twenty-fifths | ,, | ,, | South-west. |

This accumulation of ordinal and generic peculiarity of Australian vegetation in the south-west quarter of the continent, as compared with the south-east especially, is a very remarkable feature; it would still have been very striking had there been any contrasting peculiarity of climate or surface between these districts, which is not the case.

An examination of the proportions which the largest Natural Orders bear to the whole Flora affords very important data for determining the relations of a Flora. I find that half the Australian species are included under the following Orders, which I have here arranged nearly in the order of their numerical extent, and contrasted them with those of some other countries.

| | *Australia.* | *India.* | *South Africa.* | *Europe.* | *World.* |
|---|---|---|---|---|---|
| 1. | Leguminosæ. | Leguminosæ. | Compositæ. | Compositæ. | Compositæ. |
| 2. | Myrtaceæ. | Rubiaceæ. | Leguminosæ. | Leguminosæ. | Leguminosæ. |
| 3. | Proteaceæ. | Orchideæ | Ericeæ. | Cruciferæ. | Gramineæ. |
| 4. | Compositæ. | Compositæ. | Gramineæ. | Gramineæ. | Orchideæ. |
| 5. | Gramineæ. | Gramineæ. | Liliaceæ. | Umbelliferæ. | Rubiaceæ. |
| 6. | Cyperaceæ. | Euphorbiaceæ. | Irideæ. | Caryophylleæ. | Euphorbiaceæ. |
| 7. | Epacrideæ. | Acanthaceæ. | Diosmeæ. | Scrophularineæ. | Labiatæ. |
| 8. | Goodeniaceæ. | Cyperaceæ. | Scrophularineæ. | Labiatæ. | Myrtaceæ. |
| 9. | Orchideæ. | Labiatæ. | Geraniaceæ. | Ranunculaceæ. | Cyperaceæ. |

Hence it appears, that of the nine Natural Orders which together include upwards of half the known Australian Flowering Plants, three Orders are similarly characteristic of all the other areas compared, two of three areas, and two of two areas. In other words,—

Compositæ, Leguminosæ, and Gramineæ, are found in all five areas.
Cyperaceæ and Orchideæ, in three.
Epacrideæ (Ericeæ) and Myrtaceæ, in two.
Goodeniaceæ and Proteaceæ, in Australia alone.

Rude as the above data and methods of comparison are, they appear clearly to corroborate the

*f* 2

opinion, that the fundamental features of the Australian vegetation are not very different from those of the rest of the world, or than the vegetations of other large areas in the world are from one another.

## § 4.

### *On the Genera of the Australian Flora.*

The number of Genera of Australian Flowering Plants exceeds 1,300, and each genus has on the average about six species: the Monocotyledons differ in this respect from the Dicotyledons in having rather fewer species to each genus. This proportion is of course smaller than obtains for the whole globe (10·5, Lindley), for Europe (about 8), and India (about 5).

Of these genera a large number (between 500 and 600) are peculiar to Australia, but a rather larger number are common to India and its islands; 212 are European, and 146 British.

The proportion of endemic Australian genera is much larger amongst Dicotyledons, and is very conspicuously great in those Orders which themselves numerically preponderate, as *Myrtaceæ, Goodeniaceæ, Epacrideæ, Proteaceæ, Myoporineæ,* thus indicating that the generic peculiarities of the vegetation are in a certain sense restricted.

I have endeavoured to arrange approximately the principal Natural Orders with respect to the number of endemic genera they contain, and their prevalence, as follows:—

1. Orders or Natural groups characteristic of the Flora, and half whose genera are endemic.

*a.* All genera endemic:—

Hæmodoraceæ, Xerotideæ, Tremandreæ.

*b.* Upwards of three-fourths of the genera endemic:—

| | | | |
|---|---|---|---|
| Melanthaceæ. | Buettneriaceæ. | Myoporineæ. | Myrtaceæ. |
| Irideæ. | Rutaceæ. | Proteaceæ. | Cruciferæ. |
| Dilleniaceæ. | Stylidieæ. | Epacrideæ. | Cycadeæ. |
| Pittosporeæ. | Santalaceæ. | Goodeniaceæ. | |

*c.* Between half and three-quarters of the genera endemic:—

| | | | |
|---|---|---|---|
| Restiaceæ. | Umbelliferæ. | Phytolacceæ. | Saxifrageæ. |
| Leguminosæ. | Compositæ. | Stackhousiæ. | |

2. Orders or large groups characteristic of the Flora in various respects, which are numerically great, and less than half whose genera are endemic.

*a.* Few or no endemic genera:—

| | | | |
|---|---|---|---|
| Ranunculaceæ. | Boragineæ. | Polygoneæ. | Juncagineæ. |
| Loganiaceæ. | Plantagineæ. | Laurineæ. | Xyrideæ. |

*b.* Upwards of three-fourths not endemic:—

| | | | |
|---|---|---|---|
| Malvaceæ. | Droseraceæ. | Solaneæ. | Thymelææ. |
| Rhamneæ. | Polygaleæ. | Asclepiadeæ. | Urticeæ. |
| Halorageæ. | Rubiaceæ. | Scrophularineæ. | Naiadeæ. |
| Portulaceæ. | Convolvulaceæ. | Lentibularineæ. | Commelyneæ. |
| Loranthaceæ. | | | |

*c.* Between three-fourths and one-half not endemic :—

| | | | |
|---|---|---|---|
| Cruciferæ. | Verbenaceæ. | Euphorbiaceæ. | Liliaceæ. |
| Sapindaceæ. | Labiatæ. | Orchideæ. | Cyperaceæ. |
| Lobeliaceæ. | Chenopodieæ. | Smilaceæ. | Gramineæ. |
| Apocyneæ. | Amaranthaceæ. | | |

The above estimates are very rude, and intended to show tendencies in the general vegetation. It appears from them, that out of the twenty-five Orders, half of whose genera are endemic, but few are really much restricted in distribution; and that there are thirty-nine Orders universally distributed over the globe which play a conspicuous part in the vegetation of Australia, but of whose genera less than half are peculiar to that country. On the other hand, the twenty-three first-named Orders comprise considerably more than half the species of Australian Flowering Plants.

In point of number of species they contain, the Australian genera may be arranged approximately, as follows.

Above 200 species,—

Acacia.

Above 100 species,—

| | | |
|---|---|---|
| Eucalyptus. | Leucopogon. | Grevillea. |
| Melaleuca. | Stylidium. | Hakea. |

Above 50 species,—

| | | | |
|---|---|---|---|
| Pimelea. | Daviesia. | Dryandra. | Drosera. |
| Goodenia. | Eurybia. | Lepidosperma. | Dampiera. |
| Persoonia. | Boronia. | Xerotes. | Helichrysum. |
| Pultenæa. | Banksia. | Dodonæa. | Trichinium. |

These genera together comprise upwards of 2,000 species, are almost without exception very characteristic of extratropical Australian vegetation, and nearly all are highly characteristic of Australia and its islands.

One-half of the genera of Australian Flowering Plants are included in the following Orders :—

| | | | |
|---|---|---|---|
| 1. Compositæ. | 5. Cyperaceæ. | 9. Proteaceæ. | 12. Goodeniaceæ. |
| 2. Leguminosæ. | 6. Euphorbiaceæ. | 10. Scrophularineæ. | 13. Liliaceæ. |
| 3. Gramineæ. | 7. Orchideæ. | 11. Rubiaceæ. | 14. Labiatæ. |
| 4. Myrtaceæ. | 8. Epacrideæ. | | |

Of the peculiar genera of Australia, on the other hand, one-half of the whole are comprised in the following Orders :—

| | | | |
|---|---|---|---|
| 1. Compositæ. | 4. Epacrideæ. | 6. Goodeniaceæ. | 8. Orchideæ. |
| 2. Leguminosæ. | 5. Proteaceæ. | 7. Liliaceæ. | 9. Euphorbiaceæ. |
| 3. Myrtaceæ. | | | |

Had I the materials, it would have been interesting to have extended this inquiry to the character of the genera themselves, and especially as to whether the arboreous or herbaceous prevailed, one of the most striking characters of the Australian vegetation being the great number of peculiar genera, amongst which a large proportion are trees or large shrubs.

## § 5.

### *On the Tropical Australian Flora.*

There are no geographical or other features of the Australian continent which enable me to draw any natural boundary between temperate and tropical Australia. In selecting a botanical tropic of Capricorn, I hence have had recourse to the distribution of the plants themselves, and these must afford very vague data. The tropical Flora, in one form, advances further south on the west coast and on the central meridian than on the east, because of the absence of mountains, and hence of water, on the west, which causes combine to favour the prevalence of hot, desert types of vegetation, many of which advance even to Swan River. On the east coast again the climate is moister, and we hence not only find the most marked features of extratropical Australian vegetation,—*Stackhousia, Boronia, Tetratheca, Comesperma,* various genera of *Epacrideæ, Leguminosæ, Myrtaceæ,* etc., advancing in full force as far north as Moreton Bay, lat. 27°, which I have somewhat arbitrarily assumed there to be the limit of the temperate Flora,—but Palms and other tropical forms running down the coast almost to Bass's Straits. To the northward of Moreton Bay (judging especially from Mr. Bidwill's Wide Bay collections) not only do many temperate forms disappear, but tropical ones,—*Malvaceæ, Sterculiaceæ, Acanthaceæ, Euphorbiaceæ, Convolvulaceæ, Meliaceæ,* and *Sapindaceæ, Ficus,* together with numerous tropical Indian weeds,—become a prevailing feature in the landscape. The Araucarias, according to M'Gillivray (Voy. Rattlesnake, 1846–50), begin at Port Bowen and advance to Cape Melville. *Pandanus,* according to the same authority, commences at Moreton Island.

On the west coast I am puzzled where to draw the line. Judging from Drummond's herbarium, formed between the Moore and Murchison rivers (lat. 27° 30′ S.), the vegetation is there still typically that of the Swan River, though much modified, and reduced greatly in number of genera and species. Sir G. Grey, in his adventurous journey from Port Regent to Swan River, enumerates various eminently tropical forms as occurring to the north of Sharks Bay (lat. 26° S.), as Nutmeg,* *Araucaria,** *Calamus* (abundant), Vines, many Figs, and *Areca,* together with a *Banksia* of Swan River, which he distinctly alludes to as being quite exceptional (p. 247). To the southward of Sharks Bay again, he met with *Xanthorrhœa* and Sow-thistle,† both of whose northern limits he gives as 28° S., and *Zamia* (lat. 29° S.). The parallel of Sharks Bay, I have hence assumed to be north of the position of the tropic of vegetation.

In determining what may be called the tropic of vegetation, regard must be had not only to the latitude and isothermal lines, but to the abundance of the vegetation and its character: and, indeed, in such a country as Australia the latter elements are perhaps of the greatest importance, owing to the diminution northward of so many peculiar genera that make up a large proportion of the extra-tropical vegetation, and to the fact that the tropical Flora is so very poor in number of species, and deficient in such conspicuously tropical genera as Epiphytic Orchids, Palms, Ferns, *Scitamineæ,* etc. etc.

Taking all elements into consideration, of the vegetation, actual temperature, and relative hu-

* I find no notice elsewhere of these genera being found on the west coast, and suspect some error.

† Leichardt mentions the Sow-thistle as abundant in lat. 25° 30′ S. on the Gilbert range.

midity, we may assume that the tropical and temperate Australian Floras blend on both (east and west) meridians at between lat. 26° and 29° S.; and had we complete Floras of the included parallels of latitude, it would not be difficult to determine by the affinities of the peculiar (endemic) species, and the distribution of those that extend either north or south of those parallels, which to refer to the tropical Flora and which to the temperate.

With regard to the actual temperature of the Australian tropical vegetation, it approximates to the isothermal of 68°.

The general botanical features of the tropical vegetation may be gathered from the excellent narratives of Leichardt, Mitchell, M'Gillivray, Carron, and especially of Mueller, for the interior, and of Brown, Cunningham, and M'Gillivray for the coasts. The most prominent feature is the rarity of Cryptogams, which are almost wholly absent in western and central tropical Australia, and in the islands of the Gulf of Carpentaria, but are more abundant (especially the Ferns) on the north-east coast. The absence of Bamboos is another very striking feature, though these are said to abound in Arnheim's Land (Mueller, Linn. Journ. Bot. ii. p. 138). Epiphytic Orchids are also very rare. *Eucalypti* and *Acaciæ* form the mass of the arboreous and shrubby vegetation here as elsewhere throughout Australia, next to which some of the most common and noticeable arboreous features of vegetation are afforded by clumps of *Pandani* (one species indicating fresh-water in the interior), *Brachychiton, Adansonia,* on the north-west quarter, and *Cochlospermum,* and many other genera on the north-east. *Casuarina, Callitris,* and other large trees seem to be rare though not wholly wanting on the west coast.

The principal tropical phases of vegetation described by Mueller are,—

1. The varied arboreous and shrubby clothing of the eastern slopes of the eastern ranges, where numerous Indian genera of umbrageous trees are interspersed with Australian; this, called the "Brushwood," or "Cedar" country, further contains the most numerous representatives of the Polynesian and Malayan Floras; together with *Cycas* thirty feet high, and various Palms of the genera *Calamus, Areca, Caryota,* and *Livistona.*

2. The "Brigalow Scrub" extends over the elevated sandstone plains west of the coast range in east Australia, as far as the Newcastle range (lat. 18°–20°). This is also a very varied vegetation, chiefly of small trees and shrubs of *Capparideæ, Pittosporeæ, Bauhinia, Sterculiaceæ,* etc. Here *Delabechia* and *Brachychiton,* form a remarkable secondary feature; distinguished as the Bottle-tree Scrub, from their tumid trunks. This vegetation is elsewhere * described by Mueller as extending from the Burdekin to the Upper Darling rivers, and ceasing towards the south-west, somewhere near Mount Serle, Mount Murchison, or Cooper's river.

3. Open downs of basalt, nearly destitute of trees, except along watercourses. The vegetation is chiefly herbaceous, and much of it annual; the soil is rich, and after the rains produces a luxuriant crop of excellent grass and herbaceous plants.†

4. The desert presents various assemblages of plants according as the soil is saline, clayey, or sandy, but these plants are almost the same as those of extratropical Australia, with the exception of various species of *Portulaceæ, Solanum, Euphorbia, Cassia, Gomphrena, Ptilotus, Trianthema, Aylmeria,* and other *Paronychieæ.*

* Report on Plants of Babbage's Expedition, (Victoria, 1858).

† Mueller remarks that a *Verbena* forms so conspicuous a feature over large tracts of country as to have suggested the name of Vervain Plains; it is very singular that this should be the South American *V. Bonariensis,* and I should think an introduced plant.

5. The sandstone table-land presents an arid, cheerless landscape, described by Dr. Mueller in terms that apply perfectly well to the sandstone table-lands of the peninsula of India, and indeed many of the characteristic genera are common to both. These consist of *Terminalia, Melia, Cochlospermum, Sterculia, Buchanania, Zizyphus, Nauclea, Bauhinia, Indigofera, Erythrina, Gardenia, Strychnos, Santalum,* a profusion of Andropogoneous Grasses, and other shrubs and herbs, all of which the Indian botanist recognizes at once as the prominent features of the sandstone ranges of western Bengal, and central India.

6. The sea-coasts are chiefly tenanted by an Indian vegetation, consisting of *Avicennia, Rhizophoreæ, Pandaneæ, Spinifex, Zoysia, Suriana, Ægiceras, Pemphis, Tribulus,* together with *Colubrina, Ipomœa,* etc.

To these Dr. Mueller adds, as a seventh region, the banks of the northern rivers, which, however, seem scarcely to afford a peculiar vegetation.

Other plants worthy of notice, as natives of tropical Australia, are a species of *Musa* and *Nepenthes,* both mentioned by M'Gillivray, who also is the authority for the occurrence of a clump of Cocoa-nuts* on Frankland Island, for the Pomegranate on Fitzroy Island, and *Caryota urens,* at Cape York. The same naturalist discovered *Balanophora fungosa* of New Caledonia at Rockingham Bay, and no doubt there are many other plants of the Malayan and Polynesian islands still to be detected in similar localities.

The number of species in tropical Australia appears to be extremely small, owing, no doubt, much to the dryness of the climate, and to the absence of any large rivers, swamps, and mountains; as also to the short duration of the rainy season, which in many parts of the coast lasts only from November to January. Many discoveries may yet be anticipated, when it is considered how many very common tropical Indian and Malay Archipelago weeds may be found to occur here and there along the coast: but Brown spent many months on the tropical shores, and Cunningham several years; Mueller traversed northern Australia, Armstrong resided some years at Port Essington; and we have considerable collections from Bynoe, Mitchell, Bidwill, and M'Gillivray; and it must hence be doubtful whether future explorers will raise the known number of 2,200 tropical flowering species to much above 3,000.

Mueller's collections alone contain, of plants collected between the Victoria River and Moreton Bay, 160 Natural Orders, 600 Genera, and 1,790 Species, including Cryptogamia; but as the Moreton Bay Flora can hardly be called Tropical, and as Mueller includes 14 Orders which scarcely advance north of the tropic of Capricorn, I must exclude, perhaps, 500 species, including Cryptogamia, to work his results into my estimate, which includes 148 Natural Orders, 700 genera, and 2,200 species.

The most extensive tropical Natural Orders are,—

| *Australia.* | *Tropical Africa.* | *India.* | *West Indies.*† |
|---|---|---|---|
| Leguminosæ. | Leguminosæ. | Leguminosæ. | Leguminosæ. |
| Gramineæ. | Rubiaceæ. | Rubiaceæ. | Compositæ. |
| Myrtaceæ. | Gramineæ. | Orchideæ. | Rubiaceæ. |
| Compositæ. | Compositæ. | Compositæ. | Gramineæ. |

* Captain King (Voy. i. p. 194) mentions having picked up cocoa-nuts on the beach at Cape Cleveland; Flinder's (ii. p. 49) at Shoal-water Bay; and Cook's party found old husks at the mouth of the Endeavour River. To all these places the fruit or its remains was no doubt brought by currents.

† Chiefly founded on Grisebach's Essay on the Plants of Guadeloupe, etc.

| *Tropical Australia.* | *Tropical Africa.* | *India (trop. and temp.)* | *West Indies.* |
|---|---|---|---|
| Cyperaceæ. | Cyperaceæ. | Gramineæ. | Cyperaceæ. |
| Euphorbiaceæ. | Acanthaceæ. | Euphorbiaceæ. | Euphorbiaceæ. |
| Malvaceæ. | Malvaceæ. | Acanthaceæ. | Scrophularineæ. |
| Convolvulaceæ. | Euphorbiaceæ. | Cyperaceæ. | Melastomeæ. |
| Goodeniaceæ. | Convolvulaceæ. | Labiatæ. | Convolvulaceæ. |
| Proteaceæ. | Urticeæ. | | Myrtaceæ. |

Mueller has given, in his 'General Report on the Botany of the North Australian Expedition,' some valuable tables, showing approximately the order of succession in which temperate forms appear in advancing southward in Australia, and these give us a wide idea of the immensely extended distribution of many endemic species. He enumerates no less than 225 Victoria colony species as occurring to the north of lat. 26° S., and of these I find nearly 90 to be Tasmanian. Many of them are properly tropical forms that attain the latitude of Victoria only in the hot deserts, but many are essentially temperate forms. The whole are thus distributed :—

| | | | | | | |
|---|---|---|---|---|---|---|
| Lat. 17° 30′ S. | to | 20° S. | Victoria species, | 32; | Tasmania, | 10. |
| 20° | „ | 23° | „ | 24 | „ | 6. |
| 23° | „ | 26° | „ | 51 | „ | 21. |
| 26° | „ | 27° | „ | 118 | „ | 52. |

The diminution of vegetable forms in advancing from temperate to tropical Australia is to a great extent due to the rarity or absence of Orders which, though more typical of hot latitudes in other parts of the globe, abound in the temperate regions only of Australia. I have marked these with an asterisk in the following list of extratropical Australian Orders that diminish rapidly or are absent in the tropics of that continent :—

| | | | |
|---|---|---|---|
| Ranunculaceæ. | Rutaceæ. | Compositæ. | Casuarineæ. |
| *Dilleniaceæ. | Stackhousieæ. | Lobeliaceæ. | Coniferæ. |
| Cruciferæ. | *Rhamneæ. | Epacrideæ. | *Orchideæ. |
| Tremandreæ. | Rosaceæ. | Myoporineæ. | Irideæ. |
| *Buettneriaceæ. | *Myrtaceæ. | Labiatæ. | Hæmodoraceæ. |
| Geraniaceæ. | Crassulaceæ. | Plantagineæ. | *Liliaceæ. |
| Violariæ. | Cunoniaceæ. | Proteaceæ. | Junceæ. |
| Droseraceæ. | Halorageæ. | *Santalaceæ. | Xerotideæ. |
| *Polygaleæ. | Umbelliferæ. | Daphneæ. | *Restiaceæ. |

Those Orders, again, which are confined to the Tropics, are unexceptionally common Indian ones, and which it is not necessary to specify. There are, however, several of the most typically Indian Orders that are very scarce or absent in tropical Australia, amongst which the most remarkable are :—

| | | | |
|---|---|---|---|
| Anonaceæ. | Rhamneæ. | Symploceæ. | Laurineæ. |
| Menispermeæ. | Melastomaceæ. | Myrsineæ. | Cupuliferæ. |
| Guttiferæ. | Araliaceæ. | Acanthaceæ. | Dioscoreæ. |
| Celastrineæ. | Vaccinieæ. | Cyrtandreæ. | Aroideæ. |

The peculiar features of the extratropical Australian Flora are mainly kept up in its tropical quarter, by the following plants :—

Dilleniaceæ (a few genera of).
Drosera.
Pittosporeæ.
Eucalyptus, and a few other genera of Myrtaceæ.
Acacia, and a few other genera of Leguminosæ.
Stylidium.
Myoporineæ.
Grevillea, and a few other Proteacea.
Casuarina.
Callitris.
Loganiaceæ.
Restiaceæ.
Xerotideæ.

Of the tropical Australian plants nearly 500, included under 273 genera, are either identical with continental or insular Indian species, or are so very closely allied to them as to require a further examination to distinguish them.* To make this list more useful, I have given the extra-Australian and extra-Indian distribution of the species:—

*Menispermeæ.*

Stephania hernandifolia (Africa).

*Nymphæaceæ.*

Nelumbium speciosum, *Willd.* (Afr., Eu., Am.?).
Brasenia peltata, *Pursh* (North America).

*Cruciferæ.*

Nasturtium terrestre, *Br.* (Eur., Afric., Amer.).
Senebiera † integrifolia, *DC.?*

*Capparideæ.*

Polanisia viscosa, *DC.* (Africa, America).
Capparis sepiaria, *L.*

*Droseraceæ.*

Drosera Burmanni, *Vahl* (Africa).
Drosera Finlaysoniana, *Wall.*

*Violaceæ.*

Ionidium suffruticosum, *Ging.* (Africa).

*Polygaleæ.*

Polygala arvensis, *L.* (Africa).
Polygala crotalarioides, *Ham.*
Polygala Japonica, *Th.*
Polygala leptalea, *DC.* (Africa).
Polygala rosmarinifolia, *W. & A.* (Africa).

*Malvaceæ.*

Thespesia populnea, *Cav.* (Africa).
Paritium tiliaceum, *St. Hil.* (Africa, America).
Hibiscus radiatus, *L.*
Hibiscus panduriformis, *Burm.* (Africa).
Hibiscus heterophyllus, *Vent.*
Hibiscus Trionum, *L.* (Africa).
Abutilon Indicum, *L.* (Africa, America).
Abutilon graveolens (Africa, America).
Abutilon Asiaticum (Africa, America).
Sida cordifolia, *L.* (Africa, America).
Sida acuta, *Burm.* (Africa, America).
Sida rhombifolia, *L.* (Africa, America).

*Buettneriaceæ.*

Melhania incana, *Heyne.*
Heritiera littoralis, *Ait.*
Helicteres Isora, *L.*
Commersonia echinata, *Forst.*
Waltheria Indica, *L.* (Africa, America).
Melochia corchorifolia, *L.* (Africa).

*Tiliaceæ.*‡

Corchorus olitorius, *L.* (Africa).
Corchorus fascicularis, *Lam.* (Africa).
Corchorus acutangulus, *Lam.* (Africa).
Corchorus tridens, *L.* (Africa).

* I must caution my readers that this catalogue, being a first attempt, does not pretend to anything like absolute accuracy: it enumerates Australian species which a closer examination may probably prove to be different from Indian, and omits other plants that will be found eventually to be common to these countries. I have had no materials of any consequence to help me, but such as the herbarium affords; and I have had, for almost every species enumerated, to examine a very extensive suite of specimens often from various parts of the world. To render such a list worthy of as much confidence as is attainable in the present state of specific botany, would be a work of years.

† Found on Cato Reef, where Flinders's ships were wrecked; also in China, and believed to be the *S. integrifolia* of Madagascar.

‡ The absence of *Urena* and *Triumfetta* is remarkable.

Grewia orientalis, *L.?*
Grewia sepiaria, *Roxb.*
Grewia tiliæfolia, *Vahl?*
Grewia hirsuta, *Vahl.*
Grewia multiflora, *Juss.*

*Aurantiaceæ.*

Glycosmis pentaphylla, *Correa?*
Murraya exotica, *L.*

*Hippocrateaceæ.*

Hippocratea Indica, *Willd.*

*Olacaceæ.*

Opilia amentacea, *Roxb.*
Cansjera scandens, *Roxb.*
Ximenia Americana, *L.* (Africa, America).

*Hypericaceæ.*

Hypericum Japonicum, *Th.*

*Guttiferæ.*

Calophyllum inophyllum, *L.* (Africa).

*Malpighiaceæ.*

Tristellateia Australasica, *A. Rich.*

*Sapindaceæ.*

Dodonæa Burmanni, *DC.* (Africa).
Cardiospermum Halicacabum, *L.* (Africa, America).
Erioglossum edule, *Bl.*

*Ampelideæ.*

Leea sambucina, *L.*
Cissus lanceolaria, *Roxb.?*
Cissus adnatus, *Wall.?*

*Meliaceæ.*

Melia composita, *Willd.*
Xylocarpum granatum, *Kœn.*
Sandoricum Indicum, *L.*
Sandoricum nervosum, *Bl.*

*Pittosporeæ.*

Pittosporum ferrugineum, *Ait.?*

*Oxalideæ.*

Oxalis corniculata, *L.* (Africa, America).

*Zygophyllaceæ.*

Tribulus cistoides, *L.* (Africa, America).

*Simarubaceæ.*

Brucea Sumatrana, *Roxb.*

*Terebinthaceæ.*

Garuga floribunda, *Dcne.*
Buchanania angustifolia, *Wall.*

*Rhamneæ.**

Colubrina Asiatica, *Brong.* (Africa).

*Leguminosæ.*

Crotalaria verrucosa, *L.* (Africa, America).
Crotalaria calycina, *Schrenck.*
Crotalaria juncea, *L.* (Africa).
Crotalaria linifolia, *L. fil.*
Crotalaria medicaginea, *Lam.*
Crotalaria medicaginea, *var.* neglecta.
Crotalaria laburnifolia, *L.*
Crotalaria incana, *L.* (Africa, America).
Crotalaria trifoliastra *Willd.* (Africa, America).
Crotalaria retusa, *L.* (Africa).
Rothia trifoliata, *Pers.*
Indigofera linifolia, *Retz* (Africa).
Indigofera cordifolia, *Heyne* (Africa).
Indigofera enneaphylla, *L.*
Indigofera trifoliata, *L.*
Indigofera viscosa, *Lam.* (Africa).
Indigofera hirsuta, *L.* (Africa).
Tephrosia purpurea, *Pers.* (Africa).
Sesbania Ægyptiaca, *Pers.* (Africa).
Sesbania aculeata, *Pers.* (Africa).
Æschynomene Indica, *L.* (Africa).
Zornia diphylla, *Pers.* (Africa, America).
Alysicarpus scariosus, *Grah.*
Alysicarpus scariosus, *var.* thyrsiflorus.
Dendrolobium umbellatum, *Bth.* (Africa).
Uraria Lagopus, *DC.*
Dicerma biarticulatum, *DC.*
Desmodium polycarpum, *DC.* (Africa, America).
Desmodium concinnum, *DC.*
Lespedeza cuneata, *G. Don.*
Galactia tenuiflora, *W. & A.*
Canavalia obtusifolia, *DC.* (Africa, America).
Phaseolus radiatus, *L.*

* The rarity of *Zizyphus* in Australia is remarkable.

Phaseolus Truxillensis, *H. B. K.*
Vigna anomala, *Vahl* (Africa).
Rhynchosia minima, *DC.* (Africa).
Flemingia lineata, *Roxb.*
Flemingia semi-alata, *Roxb.*
Eriosema virgatum, *Bth.*
Pycnospora hedysaroides, *Br.*
Derris uliginosa, *Bth.* (Africa).
Brachypterum scandens, *Bth.*
Pongamia glabra, *Ait.* (Africa).
Sophora tomentosa, *L.* (Africa, America).
Guilandina Bonducella, *L.* (Africa, America).
Cæsalpinia sepiaria, *Roxb.*
Cæsalpinia paniculata, *Roxb.*
Cassia occidentalis, *L.* (Africa, America).
Cassia mimosoides, *L.* (Africa, America).
Cassia Absus, *L.* (Africa).
Cynometra ramiflora, *L.?*
Adenanthera pavonina, *L.?*
Acacia Farnesiana, *Willd.* (Africa, America).
Albizzia Lebbek, *Bth.* (Africa).

*Rosaceæ.*

Rubus rosæfolius, *Sm.* (Africa).
Rubus acerifolius, *Wall.*

*Combretaceæ.*

Laguncularia coccinea, *Gaud.*
Terminalia Bellerica, *Roxb.?*

*Rhizophoreæ.*

Carallia integerrima, *DC.*
Ceriops Candolleana, *W. & A.*
Bruguiera Rheedii, *Bl.*
Rhizophora mucronata, *Lam.* (Africa).

*Onagraceæ.*

Jussieua repens, *L.* (Africa, America).
Jussieua villosa, *Lam.* (Africa, America).
Jussieua angustifolia, *Lam.* (America).
Ludwigia parviflora, *Wall.*
Rotala illecebroides, *L.*
Rotala verticillaris, *L.*
Ammannia auriculata, *Lam.* (Africa).
Ammannia multiflora, *Roxb.* (Africa).
Ammannia vesicatoria, *Roxb.* (Africa).
Pemphis acidula, *Forst.* (Africa).

*Halorageæ.*

Myriophyllum Indicum, *L.?*
Ceratophyllum submersum, *L.* (Eur., Afr., Amer.).

*Myrtaceæ.*

Barringtonia acutangula, *Gært.*
Sonneratia acida, *L.*
Careya arborea, *Roxb.*

*Melastomaceæ.*

Melastoma Malabathricum, *L.*

*Portulaceæ.*

Portulaca oleracea, *L.* (Africa, America).
Sesuvium Portulacastrum (Africa, America).
Trianthema decandra, *L.*
Mollugo Spergula, *L.* (Africa, America).
Glinus lotoides, *L.* (Africa, America).

*Paronychieæ.*

Polycarpæa corymbosa, *Lam.* (Africa).
Polycarpæa spicata, *W. & A.?* (Africa).

*Crassulaceæ.*

Bryophyllum calycinum, *L.* (Africa).

*Incert. sed.*

Suriana maritima, *L.* (Africa, America).

*Cucurbitaceæ.*

Mukia scabrella, *Arn.* (Africa).
Lagenaria vulgaris, *Ser.* (Africa).
Bryonia laciniosa, *L.* (Africa).

*Umbelliferæ.*

Hydrocotyle Asiatica, *L.* (Africa, America).

*Rubiaceæ.*

Morinda citrifolia, *L.?*
Stylocoryne racemosa, *Cav.?*
Dentella repens, *Forst.*
Guettarda speciosa, *L.* (Africa).
Epithinia Malayana, *Jack.*
Pavetta Indica, *L.*
Ixora coccinea, *L.*
Hedyotis racemosa, *Lam.*

*Compositæ.*

Vernonia cinerea, *Less.* (Africa, America).

Elephantopus scaber, *L.* (Africa, America).
Eclipta erecta, *L.* (Africa, America).
Sphæranthus hirtus, *Willd.*
Sphæranthus microcephalus, *Willd.*
Blumea hieraciifolia, *DC.*
Blumea Wightiana, *DC.*
Blumea lacera, *DC.* (Africa).
Pluchea Indica, *Less.*
Monenteles redolens, *Lab.*
Monenteles spicatus, *Lab.*
Siegesbeckia orientalis, *L.* (ubique terr.).
Wedelia calendulacea, *Less.*
Wedelia urticæfolia, *DC.?*
Wollastonia biflora, *DC.*
Bidens leucantha, *Willd.* (Africa, America).
Spilanthes Acmella, *L.* (Africa, America).
Myriogyne minuta (Africa, America).
Gnaphalium luteo-album, *L.* (ubique).
Youngia Thunbergiana, *DC.* (Africa).

*Goodeniaceæ.*

Scævola Kœnigii, *Vahl* (Africa).

*Symploceæ.*

Symplocos sp.?

*Sapotaceæ.*

Mimusops Kauki, *L.*
Ægiceras majus, *L.*

*Primulaceæ.*

Centunculus tenellus, *Duby* (Brazil!).

*Asclepiadeæ.*

Dischidia nummularia, *Br.*

*Apocyneæ.*

Cerbera Odollam, *Gærtn.*

*Loganiaceæ.*

Mitreola oldenlandioides, *Wall.*
Mitrasacme capillaris, *Wall.?*

*Convolvulaceæ.*

Cuscuta Chinensis, *Lamk.*
Batatas paniculata, *Chois.* (Africa).
Pharbitis Nil, *Chois.* (Africa).
Convolvulus parviflorus, *Vahl.*
Ipomœa filicaulis, *Bl.* (Africa).
Ipomœa pend ula*Forst.* (Africa).
Ipomœa Coptica, *Roth* (Africa).
Ipomœa dasysperma, *Jacq.*
Ipomœa reptans, *Poir.* (Africa).
Ipomœa Pes-capræ, *L.* (Africa, America).
Ipomœa rugosa, *Chois.* (Africa).
Ipomœa tridentata, *Roth* (Africa).
Ipomœa Turpethum, *Br.* (Africa).
Ipomœa dissecta, *Willd.*
Ipomœa sessiliflora, *Roth* (Africa).
Ipomœa chryseidis, *Br.* (Africa).
Ipomœa pentadactyla, *Chois.*
Cressa Cretica, *L.* (Africa, America).
Evolvulus linifolius, *L.* (Africa, America).
Evolvulus alsinoides, *L.* (Africa).
Hydrolea Zeylanica, *L.* (Africa, America).

*Solaneæ.*

Solanum verbascifolium, *L.* (Africa).
Solanum nigrum, *L.* (ubique).
Solanum Indicum, *L.* (Africa).
Solanum auriculatum, *Ait.* (Africa, America).
Solanum xanthocarpum, *Schrad.?*
Physalis parviflora, *Br.* (Africa, America).

*Boragineæ.*

Coredia Myxa, *L.* (Africa).
Coredia subcordata, *Lam.* (Africa).
Coredia orientalis, *Br.?*
Coredia dichotoma, *Forst.*
Ehretia serrata, *Roxb.?*
Coldenia procumbens, *L.* (Africa).
Tournefortia argentea, *L.* (Africa).
Heliotropium Coromandelianum, *Retz* (Africa).
Heliotropium Europæum, *L.* (Africa).
Trichodesma Zeylanicum, *Br.* (Africa).

*Scrophularineæ.*

Mimulus gracilis, *Br.* (Africa).
Limnophila gratioloides, *Br.* (Africa, America).
Herpestis Monnieria, *H.B.K.* (Africa, America).
Herpestis floribunda, *Br.* (Africa).
Vandellia crustacea, *Bth.* (Africa, America).
Scoparia dulcis, *L.* (ubique).
Microcarpæa muscosa, *Br.*
Buchnera hispida, *Harr.* (Africa).

Striga hirsuta, *Bth.* (Africa).
Centranthera hispida, *Br.*

*Acanthaceæ.*

Adenosma uliginosa, *Br.*
Nelsonia tomentosa, *Willd.* (Africa).
Rostellularia procumbens, *Nees.*

*Verbenaceæ.*

Verbena officinalis, *L.* (Africa).
Lippia nodiflora, *Rchb.* (Africa).
Premna serratifolia, *L.* (Africa).
Callicarpa longifolia, *Lam.?*
Callicarpa cana, *L.?* (Africa).
Clerodendron inerme, *Br.*
Vitex trifolia, *L.* (Africa).
Vitex Negundo, *L.* (Africa).
Avicennia tomentosa, *L.* (Africa, America).

*Labiatæ.*

Moschosma polystachyum, *Bth.* (Africa).
Orthosiphon stramineus, *Bth.* (Africa).
Anisomeles Heyneana, *Bth.?*
Coleus atro-purpureus, *Bth.*
Dysophylla verticillata, *Bth.* (Africa).
Salvia plebeja, *Br.*
Leucas flaccida, *Br.*

*Lentibularineæ.*

Utricularia graminifolia, *Vahl.*

*Plumbagineæ.*

Ægialitis annulata, *Br.*
Plumbago Zeylanica, *L.* (Africa, America).

*Nyctagineæ.*

Pisonia aculeata, *L.?* (Africa, America).
Pisonia excelsa, *Blume.*
Boerhaavia diffusa, *L.* (Africa).
Boerhaavia repanda, *Willd.* (Africa).

*Polygoneæ.*

Polygonum plebejum, *Br.*
Polygonum lanigerum, *Br* (Africa).
Polygonum orientale, *L.*
Polygonum barbatum, *L.* (Africa).
Polygonum flaccidum, *Roxb.* (Africa, America).
Polygonum mite, *var.* serrulatum (Africa).
Polygonum minus, *Huds.*
Polygonum lapathifolium (Africa, America).
Polygonum glabrum, *Willd.* (Africa, America).
Polygonum strigosum, *Br.*

*Chenopodiaceæ.*

Salicornia Arbuscula, *L.* (Africa).
Salicornia Indica, *Willd.* (Africa).
Chenopodina maritima, *Moq.* (Africa, America).
Salsola brachypteris, *Moq.*

*Amaranthaceæ.*

Deeringia celosioides, *Br.* (Africa).
Euoxolus viridis, *Moq.* (Africa, America).
Amaranthus spinosus, *L.* (Africa, America).
Ptilotus corymbosus, *Br.*
Achyranthes canescens, *Br.*
Achyranthes aspera, *L.* (Africa, America).
Achyranthes porphyrostachys, *Wall.* (Africa).
Centrostachys aquatica, *Wall.* (Africa).
Alternanthera nodiflora, *Br.* (Africa, America).
Alternanthera denticulata, *Br.* (Africa, America).

*Laurineæ.*

Gyrocarpus Asiaticus, *Willd.*
Tetranthera monopetala, *Roxb.*
Hernandia Sonora, *L.* (Africa, America).

*Daphneæ.*

Wickstrœmia Indica, *C. A. M.*

*Santalaceæ.*

Exocarpus latifolia, *Br.*

*Euphorbiaceæ.*

Euphorbia Chamæsyce, *Willd.* (Africa, America)
Euphorbia hypericifolia, *L.* (Africa).
Euphorbia bifida, *Hook.*
Homalanthes populifolius, *Grah.*
Rottlera tinctoria, *Roxb.*
Phyllanthus Niruri, *L.* (Africa, America).
Microstachys chamælea, *A. Juss.* (Africa).
Briedelia tomentosa, *Bl.*
Flüggea leucopyris, *Willd.*
Flüggea virosa, *Roxb.*
Melanthesa Chinensis, *Bl.*

*Antidesmeæ.*

Antidesma paniculatum, *Roxb.* (Africa).

*Piperaceæ.*

Peperomia reflexa, *Diet.* (Africa, America).
Peperomia Dindygulensis, *Miq.?*

*Urticeæ.*

Covellia hispida, *Miq.*
Covellia oppositifolia, *Gasp.*
Fatoua Manillensis, *Walp.*
Epicarpurus orientalis, *Bl.*

*Casuarineæ.*

Casuarina equisetifolia, *Forst.*

MONOCOTYLEDONES.

*Orchideæ.*

Spiranthes australis, *Lindl.*
Microtis rara, *Br.*
Calanthe veratrifolia, *Br.*

*Hydrocharideæ.*

Vallisneria spiralis, *L.* (Africa).
Hydrilla dentata, *Casp.* (Africa).
Blyxa octandra, *Dne.*
Ottelia alismoides, *Pers.*

*Philydraceæ.*

Philydrum lanuginosum, *Br.*

*Pontederaceæ.*

Monochoria vaginalis, *Presl* (Africa).

*Burmanniaceæ.*

Burmannia distachya, *Br.*
Burmannia juncea, *Br.?*
Tacca pinnatifida (Africa).

*Dioscoreæ.*

Dioscorea glabra, *Roxb.* (Africa).
Dioscorea bulbifer, *L.* (Africa).

*Typhaceæ.*

Typha angustifolia, *L.* (ubique).

*Aroideæ.*

Dracontium polyphyllum, *L.*
Caladium macrorhizum, *Br.*

*Pistiaceæ.*

Lemna minor, *L.* (ubique).
Lemna trisulca, *L.* (ubique).

*Commelyneæ.*

Commelyna communis, *L.* (Africa, America).
Commelyna agrostophylla, *F. M.*
Commelyna salicifolia, *Roxb.* (Africa).
Cyanotis axillaris, *R. & S.*

*Naiadeæ.*

Naias minor, *L.* (Africa, America).
Halophila ovalis, *Gaud.*

*Alismaceæ.*

Potamogeton natans, *L.* (ubique).

*Melanthaceæ.*

Iphigenia Indica, *Kth.*

*Xyrideæ.*

Xyris Walkeri, *Wt.* (Africa ?)
Xyris pauciflora, *Willd.* (Africa ?)

*Junceæ.*

Juncus bufonius, *L.* (Africa).
Flagellaria Indica, *L.* (Africa).

*Restiaceæ.*

Eriocaulon sp ?

*Cyperaceæ.*

Cyperus Haspan, *L.* (Africa, America).
Cyperus polystachyus, *Rottb.* (Africa, America).
Cyperus mucronatus, *L.* (Africa, America).
Cyperus rotundus, *L.* (Africa, America).
Cyperus articulatus, *Vahl* (Africa, America).
Cyperus flavescens, *L.* (Africa, America).
Cyperus angulatus, *Nees* (Africa, America).
Cyperus pygmæus, *Vahl* (Africa, America).
Cyperus sanguinolentus, *Vahl* (Africa, America).
Cyperus inundatus, *Roxb.* (Africa).
Cyperus aristatus, *Rottb.* (Africa, America).
Cyperus canescens, *Vahl.*
Cyperus exaltatus, *Retz* (Africa).
Cyperus auricomus, *Sieb.* (Africa, America).
Cyperus Iria, *L.* (Africa).
Cyperus Pangorei, *Ham.* (Africa).
Cyperus corymbosus, *Nees* (Africa).
Mariscus cyperinus, *Nees* (Africa).
Kyllingia cylindrica, *Nees* (Africa).

Kyllingia monocephala, *Nees* (Africa, America).
Scirpus lacustris, *L.* (Africa, America).
Scirpus triqueter, *L.* (Africa, America).
Scirpus maritimus, *L.* (Africa, America).
Scirpus mucronatus, *L.* (Africa, America).
Fuirena glomerata, *Vahl* (Africa, America).
Fuirena umbellata, *Roth* (Africa, America).
Malacochæte pectinata, *Nees & Mey.* (Afr., Amer.).
Eleocharis capitatus, *Nees* (Africa, America).
Eleocharis atropurpureus, *Nees* (Africa, America).
Eleocharis acicularis, *L.* (Africa).
Eleocharis gracilis, *Br.*
Eleocharis compacta, *Br.*
Isolepis fluitans, *Br.* (Africa).
Isolepis prælongata, *Nees* (Africa).
Isolepis supina, *L.* (Africa, America).
Isolepis setacea, *Br.* (Africa).
Isolepis barbata, *Br.* (Africa).
Isolepis trifida, *Nees* (Africa, America).
Limnochloa plantaginea, *Nees* (Africa, America).
Trichelostylis xyroides, *Arn.*
Trichelostylis miliacea, *Nees* (Africa, America).
Trichelostylis quinquangularis, *Nees* (Africa).
Fimbristylis dichotoma, *Vahl.*
Fimbristylis æstivalis, *Vahl* (America).
Fimbristylis pallescens, *Nees* (Africa).
Fimbristylis Royeniana, *Nees* (Africa).
Fimbristylis diphylla, *Vahl* (Africa, America).
Fimbristylis ferruginea, *Vahl* (Africa, America).
Fimbristylis acuminata, *Nees.*
Fimbristylis nutans, *Vahl.*
Fimbristylis polytrichoides, *Vahl.*
Fimbristylis schœnoides, *Vahl.*
Abildgaardia monostachya, *Vahl* (Africa, America)
Rhynchospora Chinensis, *Nees* (Africa, America).
Rhynchospora aurea, *Vahl* (Africa, America).
Cladium Mariscus, *L.* (Africa, America).
Morisia Wallichii, *Nees* (Africa, America).
Scleria oryzoides, *Presl.*
Scleria lævis, *Retz.*
Scleria hebecarpa, *Nees ?* (Africa).
Scleria uliginosa, *Hort.* (Africa).
Scleria margaritifera, *Br.*
Diplacrum caricinum, *Br.* (Africa).
Lepironia mucronata, *Rich.* (Africa).
Carex gracilis, *Br.* (Africa).
Carex Gaudichaudiana, *Kth.*

*Gramineæ.*

Leersia hexandra, *Sw.* (Africa, America).
Leersia ciliata, *Roxb.* (Africa, America).
Oryza sativa, *L.*
Paspalum scrobiculatum, *L.* (Africa, America).
Paspalum distichum, *L.* (Africa, America).
Paspalum conjugatum, *L.* (Africa, America).
Eriochloa annulata, *Kth.* (Africa, America).
Coridochloa semialata, *Nees* (Africa).
Digitaria ciliaris, *Koch.* (Africa, America).
Digitaria sanguinalis, *L.* (Africa, America).
Panicum distachyon, *L.* (Africa, America).
Panicum fluitans, *L.* (Africa, America).
Panicum angustatum, *Tr.* (Africa, America).
Panicum brizoides, *L.* (Africa).
Panicum effusum, *Br.*
Panicum repens, *L.* (Africa, America).
Panicum prostratum, *Lamk.* (Africa).
Panicum Petivieri, *Tr.* (Africa).
Panicum miliaceum, *L.* (Africa, America).
Panicum Indicum, *L.*
Isachne australis, *Br.*
Oplismenus Indicus, *R. & S.* (Africa, America).
Oplismenus compositus, *R. & S.* (Africa, America).
Oplismenus Crus-galli, *L.* (Africa, America).
Oplismenus stagninus, *Kth.* (Africa, America).
Chamæraphis hordeacea, *Br.*
Setaria glauca, *L.* (Africa, America).
Gymnothrix Japonica, *Kth.*
Lappago racemosa, *Willd.* (Africa, America).
Spinifex squarrosus, *L.*
Sporobolus commutatus, *Br.* (Africa, America).
Polypogon Monspelianus, *L.* (Africa, America).
Phragmites communis, *L.* (Africa, America).
Microchloa setacea, *Br.* (Africa).
Chloris barbata, *Sw.* (Africa, America).
Cynodon Dactylon, *L.* (Africa, America).
Dactyloctenium Ægyptiacum (Africa, America).
Leptochloa cynosuroides, *R. & S.* (Afr., Amer.).
Leptochloa filiformis, *R. & S.* (Africa, America).
Eleusine radulans, *Br.*
Gymnopogon digitatus, *Nees.*
Eragrostis Zeylanica, *Nees.*
Eragrostis Brownii, *Nees* (Africa).
Eragrostis verticillata, *P. B.* (Africa, America).
Glyceria fluitans, *L.* (Africa, America).
Kœleria cristata, *L.* (Africa, America).

Elytrophorus articulatus, *P. B.* (Africa).
Ophiurus corymbosus, *Gærtn.*
Rottbœllia exaltata, *L.* (Africa).
Manisuris granularis, (Africa, America).
Hemarthria compressa, *Br.* (Africa, America).
Imperata arundinacea, *Cyrill.* (Africa, America).
Heteropogon contortus, *L.* (Africa, America).
Sorghum Halepense, *L.* (Africa, America).
Ischæmum ciliare, *Nees.*
Andropogon annulatus, *Försk.* (Africa).
Andropogon pertusus, *Willd.* (Africa).
Andropogon Ischæmum, *Nees* (Africa, America).
Andropogon striatus, *Willd.?* (Africa).
Spodiopogon angustifolius, *Tr.*
Chrysopogon acicularis, *L.* (Africa).
Chrysopogon Gryllus, *L.* (Africa).
Zoysia pungens, *Willd.* (Africa).
Arundinella miliacea, *Nees* (Africa, America).

This catalogue offers many points worthy of discussion, but which it would be beyond the object and scope of this Essay to discuss. The Indian botanist will recognize the double element, one consisting of a littoral and the other of an inland Flora, the former prevalent over the shores of both Indian peninsulas, the Malay and Philippine islands, and, to a certain extent, the Louisiade and Western Pacific groups; the other or inland Indian Flora characteristic of the Carnatic, the sandstone table-lands of the western Peninsula of India, and which reappears in the Upper Birma valley, where the climate of this becomes dry for a considerable portion of the year. A list of representative Indian species would have added greatly to its value, as further establishing the close relationship between endemic Floras of central Australia and central India, for it would include many species of the following conspicuous Indian genera which are not enumerated in the foregoing list:—

| | | | |
|---|---|---|---|
| Wormia. | Desmodium. | Gardenia. | Plectranthus. |
| Cocculus. | Agati. | Randia. | Anisomeles. |
| Nymphæa. | Clitoria. | Petunga. | Endiandra. |
| Cleome. | Canavalia. | Spermacoce. | Cryptocarya. |
| Phoberos. | Mucuna. | Adenostemma. | Claoxylon. |
| Adansonia. | Erythrina. | Maba. | Sponia. |
| Sterculia. | Brachypterum. | Diospyros. | Pouzolzia. |
| Cochlospermum. | Pongamia. | Olea. | Urostigma. |
| Limonia. | Flemingia. | Bæobotrys. | Ficus. |
| Micromelon. | Mezoneuron. | Jasminum. | Crinum. |
| Clausenia. | Phanera. | Villarsia. | Curculigo. |
| Olax. | Neptunia. | Carissa. | Asparagus. |
| Cupania. | Pithecolobium. | Tabernæmontana. | Smilax. |
| Turræa. | Grislea. | Wrightia. | Calamus. |
| Xanthoxylon. | Lawsonia. | Sarcostemma. | Areca. |
| Celastrus. | Eugenia. | Tylophora. | Corypha. |
| Elæodendron. | Zanonia. | Marsdenia. | Leptaspis. |
| Ventilago. | Zehneria. | Breweria. | Cenchrus. |
| Semecarpus. | Luffa. | Physalis. | Aristida. |
| Canarium. | Cucumis. | Limnophila. | Dimeria. |
| Psoralea. | Modecca. | Gmelina. | Anthistiria. |
| Tephrosia. | Loranthus. | Tecoma. | Ratzeburgia. |
| Sesbania. | Viscum. | Spathodia. | |

Another point is the much larger proportion of Monocotyledons than of Dicotyledons; of the former class fully one-third of all the tropical species are also found in India, of the latter not one-fifth. The number of arboreous and shrubby plants is very considerable, showing that this portion of the Flora is not wholly made up of transported weeds.

Lastly, I have to allude to the remarkable absence of any reciprocity between the vegetation of Australia and India, for though I have given nearly 500 Indian species, and upwards of 200 genera, that are very decidedly Indian types of vegetation, I am not aware of a single Australian species in central India or in the western Indian peninsula, or one Australian genus that is common there. The only Australian genera that are found in any part of India proper are *Stylidium* (of which a very few species are found in the eastern Peninsula, and one in eastern Bengal, Ceylon, and the country near Calcutta), *Lagenophora* and *Haloragis*, which are temperate forms, and the following, which are confined in India to the Malayan Peninsula, or the country immediately adjoining it.

| | | | |
|---|---|---|---|
| Philydrum. | Casuarina. | Tristania. | Metrosideros. |
| Dacrydium. | Leucopogon. | Leptospermum. | |

To the eastward of India again *Bæckia* attains the latitude of southern China and the Philippines. *Microtis rara* inhabits New Zealand, Java, and Bonin; *Thelymitra* is also Javanese; a species of *Stackhousia* is found in the Philippines; one of the Indian Stylidiums inhabits Hongkong, and *Carex littorea* (an extra-tropical plant) is a native of Japan.

According to the hitherto prevailing theory of the distribution of plants, this presence of so many Indian species in tropical Australia would be accounted for by trans-oceanic migration, but this theory offers no explanation of the total absence of Australian species and typical genera in the tropical parts of India. *Eucalyptus, Acacia, Stylidium,* and *Goodeniaceæ,* are characteristic of tropical as well as of temperate Australia, together with various peculiar genera of *Leguminosæ, Compositæ, Myrtaceæ, Myoporineæ, Loganiaceæ, Restiaceæ, Coniferæ,* and *Orchideæ,* which are not represented in tropical India.

Some of these genera (*Acacia, Eucalyptus,* and *Casuarina*) flourish when planted in the Peninsula of India, and it would be interesting to know whether they become naturalized, for it appears to me to be difficult to conceive that there should be anything in the condition of the soil, vegetation, or climate of India that would wholly oppose the establishment of Australian plants, had they been transported thither by natural causes now in operation; and I cannot suppose that there should have been no migration from Australia to India if there was such a migration in the opposite direction as would account for so great a community of vegetation between these continents.

## § 6.

### *On the Flora of Extra-tropical Australia.*

In studying the extra-tropical Flora of Australia, the first phenomenon that attracts attention is the remarkable difference between the eastern and western quarters, to which there is nothing analogous in the tropical region. What differences there are between eastern and western tropical Australia are confined to more Asiatic forms in the latter, and more Polynesian and temperate Australian ones in the former; this is analogous to that preponderance, to which I shall hereafter allude, of the South African types in south-western Australia, and of New Zealand and Antarctic ones in south-eastern; but offers nothing analogous to the fact that the species, and in a great extent the genera, of south-western Australia differ from those of south-eastern, though these species and genera belong to the same Natural Orders, and in many cases to peculiarly Australian Orders or divisions of Orders.

I have endeavoured to estimate this difference by tabulating the genera and species of each country, and though the results must, in the present state of our knowledge, be very vague, they may serve to give an approximate idea of the amount of difference, which it is all the more important to do because I believe the phenomenon to be without a parallel in the geography of plants. These Floras I estimate as containing about—

| *South-western.* | | *The South-eastern Flora, including Tasmania.* | |
|---|---|---|---|
| Natural Orders | 90 | Natural Orders | 125 |
| Genera | 600 | Genera | 700 |
| Species | 3,600 | Species | 3,000 |

As far as I can make out, about one-fifth of the south-eastern species are found beyond that area; but only one-tenth of them are found in south-western Australia.

I need not remind my readers that these countries are in the same parallel of latitude, are not remarkably different in physical conditions, or indeed by any means so different as others (Greece and Spain for example) that present no such contrast, and that the extreme distance between them is only 1700 miles, with continuous land throughout. What differences there are in conditions would, judging from analogy with other countries, favour the idea that south-eastern Australia, from its far greater area, many large rivers, extensive tracts of mountainous country and humid forests, would present much the most extensive Flora, of which only the drier types could extend into south-western Australia. But such is not the case altogether, for though the far greater area is much the best explored, presents more varied conditions, and is tenanted by a larger number of Natural Orders and genera, these contain fewer species by several hundreds.

Of the largest genera of south-eastern and south-western Australia there are very few species common to both countries, as the following list, arranged in order of their magnitude, will show.*

*South-eastern Australia.*

| | Species. | Sp. found in S.W. | | Species. | Sp. found in S.W. |
|---|---|---|---|---|---|
| Acacia | 133 | 0 | Melaleuca | 27 | 0 |
| Grevillea | 67 | 0 | Helichrysum | 25 | 3 |
| Eucalyptus | 55 | 0 | Brachycome | 24 | 4 |
| Pultenæa | 50 | 0 | Xerotes | 24 | 0 |
| Leucopogon | 50 | 0 | Prasophyllum | 23 | 2 |
| Persoonia | 40 | 0 | Pterostylis | 22 | 2 |
| Eurybia | 36 | 1 | Senecio | 20 | 4 |
| Pimelea | 35 | 1 | Hibbertia | 18 | 0 |
| Epacris | 34 | 0 | Phebalium | 17 | 0 |
| Prostanthera | 30 | 0 | Bossiæa | 17 | 1 |
| Goodenia | 30 | 0 | Carex | 17 | 6 |
| Hakea | 28 | 1 | Ozothamnus | 17 | 0 |
| Boronia | 27 | 0 | Pleurandra | 16 | 0 |

* This list is very far from complete, but is in so far founded on exact data as that I have satisfied myself of the whole number of species alluded to in the first column of figures being absent in the collections I have examined from south-west Australia, except when otherwise stated. Future observations will no doubt modify its details without vitiating the general result.

| | Species. | Sp. found in S.W. | | Species. | Sp. found in S.W. |
|---|---|---|---|---|---|
| Lepidosperma | 16 | 2 | Veronica | 13 | 1 |
| Daviesia | 16 | 0 | Utricularia | 13 | 1 |
| Bæckia | 16 | 0 | Hydrocotyle | 12 | 2 |
| Haloragis | 15 | 2 | Loranthus | 12 | 1 |
| Cryptandra | 15 | 0 | Asperula | 12 | 0 |
| Pomaderris | 15 | 0 | Lobelia | 12 | 3 |
| Banksia | 15 | 0 | Plantago | 12 | 3 |
| Trichinium | 15 | 1 | Polygonum | 12 | 3 |
| Cyperus | 15 | 1 | Conospermum | 12 | 0 |
| Dampiera | 14 | 2 | Caladenia | 12 | 1 |
| Isolepis | 14 | 6 | Sida | 11 | 1 |
| Dodonæa | 13 | 1 | Astrotriche | 11 | 0 |
| Gompholobium | 13 | 0 | Galium | 11 | 1 |
| Dillwynia | 13 | 1 | Stylidium | 11 | 0 |
| Cassinia | 13 | 0 | | | |

*South-western Australia.*

| | Species. | Sp. found in S.E. | | Species. | Sp. found in S.E. |
|---|---|---|---|---|---|
| Melaleuca | 100 | 0 | *Chorizema | 22 | 0 |
| Acacia | 99 | 0 | *Hemigenia | 21 | 0 |
| Stylidium | 78 | 0 | *Candollea | 20 | 0 |
| Hakea | 75 | 1 | Hibbertia | 20 | 0 |
| Grevillea | 74 | 0 | Comesperma | 20 | 2 |
| Leucopogon | 70 | 0 | Tetratheca | 20 | 1 |
| *Dryandra | 53 | 0 | Dodonæa | 20 | 1 |
| Daviesia | 48 | 0 | Restio | 20 | 0 |
| *Petrophila | 46 | 0 | Trymalium | 20 | 0 |
| Eucalyptus | 46 | 0 | Oxylobium | 20 | 0 |
| *Verticordia | 43 | 0 | Goodenia | 20 | 0 |
| Dampiera | 38 | 2 | Merkiusa | 20 | 1 |
| Banksia | 38 | 0 | Caladenia | 20 | 1 |
| Lepidosperma | 36 | 2 | *Astroloma | 18 | 0 |
| Drosera | 35 | 0 | *Andersonia | 18 | 0 |
| *Jacksonia | 31 | 0 | Leptomeria | 18 | 1 |
| *Calothamnos | 30 | 0 | Thysanotus | 18 | 1 |
| *Gastrolobium | 28 | 0 | *Thomasia | 17 | 0 |
| Calycothrix | 28 | 0 | *Genethyllis | 16 | 0 |
| Trichinium | 27 | 1 | Eurybia | 16 | 1 |
| *Isopogon | 27 | 0 | *Leschenaultia | 16 | 0 |
| Pimelea | 27 | 1 | Logania | 16 | 0 |
| Boronia | 26 | 0 | Patersonia | 16 | 0 |
| Conospermum | 26 | 0 | Chætospora | 16 | 1 |
| Schœnus | 26 | 2 | Gompholobium | 15 | 0 |
| Persoonia | 25 | 0 | Pultenæa | 15 | 0 |
| *Conostylis | 23 | 0 | Bossiæa | 15 | 1 |
| Xerotes | 23 | 0 | *Chamælaucium | 15 | 0 |

| | Species. | Sp. found in S.E. | | Species. | Sp. found in S.E. |
|---|---|---|---|---|---|
| *Adenanthos | 15 | 0 | *Sphærolobium | 11 | 0 |
| *Beaufortia | 14 | 0 | *Eutaxia | 11 | 0 |
| *Agonis | 14 | 0 | Haloragis | 11 | 2 |
| Phebalium | 13 | 1 | *Astartea | 11 | 0 |
| *Hypocalymna | 13 | 0 | Xanthosia | 11 | 0 |
| Trachymene | 13 | 0 | Helichrysum | 11 | 3 |
| Podolepis | 13 | 1 | *Halgania | 11 | 0 |
| *Anarthria | 13 | 0 | *Microcorys | 11 | 0 |
| Opercularia | 12 | 0 | Rhagodia | 11 | 2 |
| Myoporum | 12 | 0 | *Synaphea | 11 | 0 |
| Atriplex | 12 | 3 | Casuarina | 11 | 1 |
| Cassytha | 12 | 1 | *Viminaria | 11 | 0 |
| Thelymitra | 12 | 5 | | | |

This instructive table puts the most important differential features of south-eastern and south-western Australia prominently before the eye, and I would point out:—1. How greatly larger the genera of the south-western Flora are, there being 80 genera with upwards of 10 species in its column, and only 55 in the south-eastern. 2. That the 55 genera of the south-eastern Flora contain about 1,260 species, and the 55 highest of the south-western 1,727 species. 3. That of these 55 south-western genera 36 do not appear at all in the south-eastern list, and 17 (marked with a *) are absolutely confined to the south-west, or almost so.

Altogether, I find the proportion of genera to species in the south-western Flora to be 1 : 6, and in the south-eastern 1 : 4. This increased number of genera in south-eastern Australia over the south-western is mainly due to the presence of more Antarctic, European, New Zealand, and Polynesian genera in the south-east, to which I shall hereafter allude.

The proportion of species belonging to peculiar or endemic genera in the south-west is about one-third of the whole, and in the south-east one-sixth.

The proportion of species common to other countries in the south-west is about one-tenth of the Flora, and in the south-east one-sixth.

There are about 180 genera, out of about 600, in south-western Australia that are either not found at all in south-eastern, or that are represented there by a very few species only, and these 180 genera include nearly 1,100 species.

Of generally diffused Australian genera that are absent in the south-west, I find *Viola, Polygala, Epacris, Lycopus, Ajuga, Smilax,* and *Eriocaulon;* and of European genera which occur in that quarter, but which I have not seen from elsewhere in Australia, are *Echinospermum, Eritrichium, Orobanche, Althenia,* and *Lepturus,* several of which I suppose to be introduced, and, if so, will soon be found in other colonies.

This curious case of great differences in the genera and species of the two quarters of a small continent, accompanied by an increased number of species in the smaller and more isolated quarter of the continent, which is, further, by far the most uniform in physical conditions, will no doubt eventually be found to offer the best means of testing whatever theory of creation and distribution may be established. In the meantime, the theories which I have sketched in the early pages of this Essay cannot, in the present state of our geological knowledge of Australia, be brought to bear fully upon it. That no Natural Order, but that many genera, and a whole Flora of species, should be created in the smaller and more isolated area of western Australia, different from what eastern Australia presents, seems at first sight favourable to the idea that these are derivative genera and species, formed during the gradual migration of certain of the Orders and Genera of the east towards the west. But on the other hand, this massing of most of the peculiar features of the Australian Flora in the west, unmixed there with Polynesian, Antarctic, or New Zealand genera, is an argument for regarding western Australia as the centrum of Australian vegetation, whence a migration proceeded eastward; and the eastern genera and species must in such a case be regarded as the derivative forms. Had we any idea of the comparative geological age of eastern and western Australia, this inquiry might be proceeded with a little further; though even then it would be soon brought to a stand-still, by the necessity of determining the antecedents of the whole Australian Flora. This Flora, though manifestly more allied to the Indian than to any other, differs from it so organically, that it is impossible to look upon one as derived from the other, though both may have had a common parentage.

The local character of the south-western Australian plants is another singular feature that must not be overlooked in any inquiry as to the relative ages of countries and their vegetation. So singularly circumscribed are its species in area, that many are found in one spot alone, and, of some Natural Orders, the species of Swan River differ very much from those of King George's Sound. I am quite at a loss to offer any plausible reason for this rapid succession of forms in area, and the contrast in this respect between the south-western and eastern districts is all the more remarkable, because the latter also, as compared with other parts of the world, presents a very considerable assemblage of local species. But so it is, that there are far more King George's Sound species absent from the Swan River, though separated by only 200 miles of tolerably level land, than there are Tasmanian plants absent from Victoria, which are as many miles apart, and separated by an oceanic strait. It would indeed appear that the mixture of several Floras of different character in one area tends to keep down the total number of species in that area, and if so, we may connect the richness in species of the western Australian Flora with its singular uniformity of character, for it is purely Australian, without admixture of any other element. As this excessive multiplication must, under the theory of creation by variation, have occupied a great length of time, it seems to be more natural to assume, on purely botanical grounds, that the western Australian Flora is the earliest, and sent colonists to the eastern quarter, where they became mixed with Indian, Polynesian, etc., colonists, than that the western Flora was peopled by one section only of the inhabitants of the eastern quarter.

So much for the botanical aspect of the question. The geological one suggests a different explanation. That part of the Australian continent which alone is clothed with any considerable amount of vegetation, may be likened to a horse-shoe of more or less elevated land, with its convexity to the north, and a vast enclosed central depressed area, that opens to the sea on the south, and advances north almost to the Gulf of Carpentaria. According to Mr. Jukes's clever 'Sketch of the Physical Structure of Australia,' this central and southern area was recently an oceanic bay, and existing species of Mollusca are found on its surface for many miles along the coast, and inland from it, in an almost unchanged condition.* To the east of this depressed area, the mountains are far loftier and the rocks of a much greater age than to the west of it; and were the question of the age of the Floras comprised in that of the rocks they inhabit, little doubt would be enter-

* Great beds of shells, with the colours retained, are found at Jurien Bay, at forty to eighty feet above the sea-level. (Von Sommer, in Quart. Journ. Geol. Soc. v. p. 52.)

tained that the western one was modern and derivative; but in no other part of the world are recently-formed lands tenanted exclusively by endemic plants, nor do they present assemblages of very local species; on the contrary, they are inhabited by many individuals of a few species derived from surrounding countries, of which some few are so altered as to be distinguished as varieties or even species; and we cannot therefore accept the geological evidence as good for explaining the botanical phenomena.

There is another way of viewing the whole question, but one so purely speculative that I hesitate to put it forward. It is that the antecedents of the peculiar Australian Flora may have inhabited an area to the westward of the present Australian continent, and that the curious analogies which the latter presents with the South African Flora, and which are so much more conspicuous in the south-west quarter, may be connected with such a prior state of things.

## § 7.

### *On the Flora of Countries around Spencer's Gulf.*

South Australia, which now ranks as a distinct colony, has been but imperfectly explored, and is apparently very poor in species. Some notices of its botany will be found in Lindley's and Hooker's Appendices to Mitchell's Journeys; in Brown's 'Appendix to Sturt's Journey;' in Hooker's 'Kew Miscellany,' 1853, p. 105; and, more recently, in Mueller's Report on the plants collected by Mr. D. Hergolt during Babbage's expedition. They all show that the character of the Flora is intermediate between the south-eastern, south-western, and tropical Floras, the eastern being perhaps the dominant, and the tropical due to the proximity of the central desert.

Amongst the western genera and species which here approach their eastern limits are *Hibiscus hakeæfolius* and *multifidus*, *Cyanothamnus*, *Sollya heterophylla*, *Cheiranthera*, *Bossiæa sulcata*, *Templetonia retusa*, *Clianthus Dampieri*, *Nitraria Billardieri*, *Adenanthera terminalis*, *Podotheca*, *Cylindrosorus flavescens*, *Logania crassifolia*, *Anthocercis anisantha*, *Cyclotheca australica*, and *Codonocarpus acaciæformis?*

The tropical element is displayed by species of *Crotalaria*, *Polycarpæa*, *Monenteles*, *Pluchea*, *Glossogyne*, *Sarcostemma*, *Trichodesma*, *Rostellularia*, and *Santalum*. Mueller further alludes to a succulent, leafless *Euphorbia*, probably of the Indian or South African type. The absence or rarity of *Proteaceæ*, *Sophoreæ*, *Myrtaceæ*, *Diosmeæ* and *Epacrideæ*, and prevalence of *Compositæ*, *Eremophila*, *Zygophylleæ* and *Salsoleæ*, are other proofs of the tropical and desert character of the South Australian Flora.

From the examination of a considerable collection of South Australian species made by Messrs. Whitaker, Dutton, Hillebrandt, etc., I am inclined to suspect that it contains so few peculiar genera, and so large a number of species which are either identical with or strictly intermediate in character between eastern and western ones, or which are so closely allied to congeners of one or the other, that they will favour the idea of the Flora being to a very great extent derivative.

## § 8.

### *On the Tasmanian Flora.*

For an account of the physical features of Tasmania, in so far as they affect the vegetation, I must refer to Strzelecki's excellent 'Physical Description of New South Wales and Van Diemen's Land,' where the relations of the forest to the soil and elevation, and of all these features in Tasmania to those of south-eastern Australia, are well portrayed.

The primary feature of the Tasmanian Flora is its identity in all its main characters with the Victorian, and especially of the mountainous parts of that colony; it differs only in having fewer orders, genera, species, more Antarctic and New Zealand elements, and fewer tropical, all of which might be expected from its geographical position and its climate, which is much more equable and humid than any district of Australia. There is, indeed, one part of Victoria, viz. Wilson's promontory, of which the vegetation is described as peculiarly Tasmanian, and a glance at the map shows that here again geographical proximity and uniformity of vegetation go together. There are besides a very few south-western Australian types in Tasmania, that have not also been found in the eastern Australian continent.

Before proceeding with the analysis of the Tasmanian Flora, I shall give a list of the species, with the distribution of each, and indicate the Floras of which each genus may be considered most strongly representative. These are:—1. The Australian continent; 2. New Zealand and Polynesia; 3. The Antarctic Islands; 4. South American; 5. Europe (including North America, North Asia, and North India, in so far as these share European features). Many species may be classed under two or more of these divisions, as *Anemone*, which is absent in Australia and New Zealand, but is Antarctic, American, and European. I have also put an asterisk to every species considered by Mueller, Archer, or myself as probably a variety, and noted which are subalpine and alpine. Mr. Archer has further revised the list, and added "Ch." to every species found within fifteen miles of Cheshunt.

## DICOTYLEDONS.

### I. *Ranunculaceæ.*

| | Distribution of Species. | Distr. of Genera or representatives. |
|---|---|---|
| 1. Clematis coriacea, *DC.* Ch. | Australia | Europe, etc. |
| 2. Clematis *blanda, *Hook.* | ,, | |
| 3. Clematis *gentianoides, *DC.* | Tasmania. | |
| 4. Clematis linearifolia, *Steud.* | Australia. | |
| 5. Anemone crassifolia, *Hook.* | Tasmania (subalp.) | Europe, South America. |
| 6. Ranunculus aquatilis, *L.* Ch. | Tasmania, temp. zone | Europe, etc. |
| 7. Ranunculus Gunnianus, *Hook.* Ch. | Austral. (subalp.) | |
| 8. Ranunculus hirtus, *B. & S.* Ch. | ,, N. Zeal. | |
| 9. Ranunculus lappaceus, *Sm.* Ch. | ,, ,, S. Africa. | |
| 10. Ranunculus *scapigerus, *Hook* Ch. | Tasmania (subalp.). | |
| 11. Ranunculus *nanus, *Hook.* Ch. | ,, ,, | |
| 12. Ranunculus *glabrifolius, *Hook.* Ch. | ,, | |
| 13. Ranunculus *inconspicuus, *Hook.* Ch. | ,, | |
| 14. Ranunculus *cuneatus, *Hook.* Ch. | ,, Alp. | |

| | Distribution of Species. | Distr. of Genera or representatives. |
|---|---|---|
| 15. Ranunculus inundatus, *Br.* Ch. | Australia. | |
| 16. Ranunculus sessiliflorus, *Br.* Ch. | „ N. Zealand. | |
| 17. Ranunculus *Pumilio, *Br.* | Australia. | |
| 18. Caltha introloba, *Muell.* Ch. | „ | Europe, etc., S. America. |
| II. *Magnoliaceæ.* | | |
| 19. Tasmannia aromatica, *Br.* Ch. | Australia (subalp.) | N. Zealand, Fuegia, Borneo. |
| III. *Monimiaceæ.* | | |
| 20. Atherosperma moschata, *Br.* Ch. | Australia | N. Zealand, South America. |
| IV. *Dilleniaceæ.* | | |
| 21. Hibbertia procumbens, *DC.* Ch. | Tasmania | Australia. |
| 22. Hibbertia fasciculata, *Br.* Ch. | Australia. | |
| 23. Hibbertia virgata, *Br.* | „ | |
| 24. Hibbertia ericæfolia, *H.f.* | Tasmania. | |
| 25. Pleurandra acicularis, *Lab.* | Australia | Australia. |
| 26. Pleurandra sericea, *Br.* | „ | |
| 27. Pleurandra ovata, *Lab.* Ch. | „ | |
| 28. Pleurandra riparia, *Br.* Ch. | „ | |
| 29. Pleurandra hirsuta, *Hook.* | Tasmania. | |
| V. *Cruciferæ.* | | |
| 30. Cardamine radicata, *H.f.* Ch. | Tasmania (alp.) | Europe, etc. |
| 31. Cardamine stylosa, *DC.* Ch. | Australia. | |
| 32. Cardamine dictyosperma, *Hook.* Ch. | „ | |
| 33. Cardamine pratensis, *L.* Ch. | „ Europe, | |
| 34. Cardamine hirsuta, *L.* Ch. | „ ubiquitous. | |
| 35. Barbarea australis, *H.f.* Ch. | „ New Zealand | Europe, etc. |
| 36. Nasturtium terrestre, *Br.* Ch. | „ ubiquitous | Europe, etc. |
| 37. Stenopetalum lineare, *Br.* | „ | Australia. |
| 38. Hutchinsia procumbens, *Br.* | „ Europe | Europe, etc. |
| 39. Hutchinsia australis, *H.f.* | „ | |
| 40. Thlaspi ? Tasmanicum, *H.f.* | Tasmania (subalp.) | Europe, etc. |
| 41. Draba nemoralis, *L.* | Europe | Europe, South America. |
| 42. Draba Pumilio, *Br.* | Tasmania. | |
| 43. Lepidium cuneifolium, *DC.* | Australia | Europe, etc. |
| 44. Lepidium ruderale, *L.* Ch. | „ ubiquitous. | |
| 45. Lepidium foliosum, *Desv.* | „ | |
| VI. *Violariæ.* | | |
| 46. Viola hederacea, *Lab.* | Australia | Europe, etc. |
| 47. Viola betonicæfolia, *Sw.* Ch. | „ | |
| 48. Viola Cunninhamii, *H.f.* Ch. | New Zealand (subalp.). | |
| 49. Viola Caleyana, *Don.* Ch. | Australia. | |
| 50. Hymenanthera angustifolia, *Br.* Ch. | „ | Australia, New Zealand. |

## VII. *Droseraceæ.*

| | Distribution of Species. | Distr. of Genera or representatives. |
|---|---|---|
| 51. Drosera Arcturi, *Hook.* Ch. . . . . | Austral., N. Zeal. (subalp.) | Europe, South Africa, etc. |
| 52. Drosera pygmæa, *DC.* . . . . . . . | ,, ,, | |
| 53. Drosera spathulata, *Lab.* . . . . . . . | ,, ,, India. | |
| 54. Drosera binata, *Lab.* Ch. . . . . . | ,, ,, | |
| 55. Drosera Planchoni, *H.f.* . . . . . . . | ,, | |
| 56. Drosera auriculata, *Back.* Ch. . . . . | ,, New Zealand. | |
| 57. Drosera peltata, *Sw.* . . . . . . . . | ,, ,, | |
| 58. Drosera gracilis, *H.f.* Ch. . . . . . | Tasmania (subalp.). | |
| 59. Drosera foliosa, *H.f.* . . . . . . . . | Australia. | |

## VIII. *Pòlygaleæ.*

| | | |
|---|---|---|
| 60. Comesperma volubilis, *Lab.* Ch. . . . | Australia. . . . . . . | Australia. |
| 61. Comesperma retusa, *Lab.* Ch. . . . . | ,, | |
| 62. Comesperma ericina, *DC.* . . . . . | ,, | |
| 63. Comesperma calymeja, *Lab.* . . . . . . | ,, | |

## IX. *Tremandreæ.*

| | | |
|---|---|---|
| 64. Tetratheca ciliata, *Lindl.* . . . . . . . | Australia . . . . . . | Australia. |
| 65. Tetratheca glandulosa, *Lab.* Ch. . . . | ,, | |
| 66. Tetratheca pilosa, *Lab.* Ch. . . . . . | ,, | |
| 67. Tetratheca *procumbens, *Gunn.* Ch. . . | Tasmania. | |
| 68. Tetratheca *Gunnii, *H.f.* . . . . . . | ,, | |

## X. *Pittosporeæ.*

| | | |
|---|---|---|
| 69. Billardiera longiflora, *Lab.* Ch. . . . . | Australia . . . . . . | Australia. |
| 70. Billardiera mutabilis, *Lab.* Ch. . . . . | ,, | |
| 71. Billardiera *macrantha, *H.f.* . . . . | Tasmania. | |
| 72. Pittosporum bicolor, *Hook.* Ch. . . . | Australia . . . . . . | India, etc. |
| 73. Bursaria spinosa, *Cav.* Ch. . . . . . . | ,, . . . . . . . . | Australia. |
| 74. Bursaria procumbens, *Putt.* . . . . . . | ,, | |

## XI. *Frankeniaceæ.*

| | | |
|---|---|---|
| 75. Frankenia pauciflora, *DC.* . . . . . | Australia . . . . . . | Europe, etc. |

## XII. *Caryophylleæ.*

| | | |
|---|---|---|
| 76. Spergularia rubra, *St. Hil.* . . . . . | Australia (ubiquitous) . . | Europe, etc. |
| 77. Scleranthus biflorus, *H.f.* Ch. . . . . | ,, New Zealand . . | Europe, etc. |
| 78. Scleranthus *fasciculatus, *H.f.* Ch. . . | Tasmania (subalp.). | |
| 79. Scleranthus diander, *Br.* Ch. . . . . | Australia. | |
| 80. Colobanthus Billardieri, *Fenzl* . . . . | New Zealand . . . . . | New Zealand, Antarctic. |
| 81. Colobanthus *affinis, *H.f.* Ch. . . . . | Tasmania (subalp.). | |
| 82. Stellaria multiflora, *Hook.* . . . . . | Australia, New Zealand . . | Europe, etc. |
| 83. Stellaria media, *Sw.* Ch. . . . . . . | ,, Europe, Antarctic. | |
| 84. Stellaria glauca, *With.* Ch. . . . . . | ,, Europe. | |
| 85. Stellaria pungens, *Brongn.* Ch. . . . . | ,, | |

### XIII. *Lineæ.*

| | Distribution of Species. | Distr. of Genera or representatives. |
|---|---|---|
| 86. Linum marginale, *A.C.* Ch. | Australia | Europe, etc. |

### XIV. *Elatineæ.*

| | | |
|---|---|---|
| 87. Elatine Americana, *Arn.* Ch. | Austral., N. Zeal., N. Amer. | Europe, etc. |

### XV. *Malvaceæ.*

| | | |
|---|---|---|
| 88. Lavatera plebeja, *Sims* | Australia | Europe, etc. |
| 89. Lawrencia spicata, *Hook.* | „ | Australia. |
| 90. Plagianthus pulchellus, *A. Gray.* Ch. | „ | Australia, New Zealand. |
| 91. Plagianthus sidoides, *Hook.* | „ | |

### XVI. *Buettneriaceæ.*

| | | |
|---|---|---|
| 92. Lasiopetalum discolor, *Hook.* | Tasmania | Australia. |
| 93. Lasiopetalum Gunnii, *Steetz* | „ | |
| 94. Lasiopetalum micranthum, *H.f.* | „ | |

### XVII. *Elæocarpeæ.*

| | | |
|---|---|---|
| 95. Aristotelia peduncularis, *H.f.* Ch. | Tasmania (subalp.) | Austr., N. Zeal., S. Amer. |

### XVIII. *Hypericineæ.*

| | | |
|---|---|---|
| 96. Hypericum gramineum, *Forst.* Ch. | Aust., N. Zeal., India? S. Af.? | |
| 97. Hypericum *Japonicum, *Thunb.* Ch. | „ „ „ „ | |
| 98. Eucryphia lucida, *Spach.* Ch. | Tasmania (subalp.) | South America. |
| 99. Eucryphia *Milligani, *H.f.* | „ „ | |

### XIX. *Sapindaceæ.*

| | | |
|---|---|---|
| 100. Dodonæa viscosa, *Forst.* | Aust., N. Zeal., ubiq. | Trop. India, etc. |
| 101. Dodonæa salsolæfolia, *A.C.* | Australia. | |

### XX. *Geraniaceæ.*

| | | |
|---|---|---|
| 102. Geranium dissectum, *L.*, var. | Aust., N. Zeal., Eur., Amer. | Europe, etc. |
| 103. Geranium *potentilloides, *L'Hérit.* | „ „ | |
| 104. Geranium brevicaule, *Hook.* Ch. | Austral., N. Zeal. (subalp.) | |
| 105. Pelargonium australe, *Willd.* Ch. | Australia, South Africa? | Australia, South Africa. |
| 106. Pelargonium *Acugnaticum, *Pet. Th.* Ch. | New Zealand, South Africa. | |

### XXI. *Oxalideæ.*

| | | |
|---|---|---|
| 107. Oxalis Magellanica, *Forst.* Ch. | N. Zeal., Antarct. (subalp.) | Europe, etc. |
| 108. Oxalis corniculata, *L.* | ubiquitous. | |

### XXII. *Zygophylleæ.*

| | | |
|---|---|---|
| 109. Rœpera Billardieri, *A. Juss.* | Australia | Australia. |
| 110. Rœpera latifolia, *H.f.* | „ | |

### XXIII. *Rutaceæ.*

| | | |
|---|---|---|
| 111. Correa rufa, *Gærtn.* | Australia | Australia. |
| 112. Correa Backhousiana, *Hook.* | „ | |

| | Distribution of Species. | Distr. of Genera or representative. |
|---|---|---|
| 113. Correa Lawrenciana, *Hook.* Ch. | Australia. | |
| 114. Correa speciosa, *Andr.* | ,, | |
| 115. Phebalium Billardieri, *A. Juss.* Ch. | ,, | Australia, New Zealand. |
| 116. Phebalium montanum, *Hook.* | Tasmania (alpine). | |
| 117. Phebalium truncatum, *H.f.* Ch. | Australia ? | |
| 118. Phebalium Daviesii, *H.f.* | Tasmania. | |
| 119. Eriostemon verrucosum, *A. Rich.* | Australia | Australia. |
| 120. Eriostemon virgatum, *A. Cunn.* | ,, | |
| 121. Zieria lanceolata, *Br.* Ch. | ,, | Australia. |
| 122. Boronia rhomboidea, *Hook.* Ch. | Tasmania | Australia. |
| 123. Boronia pilonema, *Lab.* Ch. | Australia. | |
| 124. Boronia hyssopifolia, *Sieb.* Ch. | ,, | |
| 125. Boronia pilosa, *Lab.* Ch. | ,, | |
| 126. Boronia variabilis, *Hook.* Ch. | ,, | |
| 127. Boronia *Gunnii, *H.f.* Ch. | Tasmania. | |
| 128. Boronia *citriodora, *Gunn.* Ch. | ,, | |
| 129. Boronia *dentigera, *F. Muell.* | Australia. | |
| 130. Acradenia Frankliniæ, *Kippist* | Tasmania | Tasmania. |

XXIV. *Rhamneæ.*

| | | |
|---|---|---|
| 131. Discaria australis, *Hook.* Ch. | Australia, New Zealand | Aust., N. Zeal., S. Amer. |
| 132. Cryptandra obcordata, *H.f.* | Tasmania | Australia. |
| 133. Cryptandra vexillifera, *Hook.* | Australia. | |
| 134. Cryptandra Lawrencii, *H.f.* | Tasmania. | |
| 135. Cryptandra eriocephala, *H.f.* | ,, | |
| 136. Cryptandra ulicina, *Hook.* | ,, | |
| 137. Cryptandra Gunnii, *H.f.* | ,, | |
| 138. Cryptandra mollis, *H.f.* | Australia. | |
| 139. Cryptandra ? parvifolia, *H.f.* | Tasmania. | |
| 140. Cryptandra obovata, *H.f.* | ,, | |
| 141. Cryptandra Sieberi, *Fenzl* | Australia. | |
| 142. Cryptandra alpina, *H.f.* Ch. | Tasmania (alpine). | |
| 143. Cryptandra pimeleoides, *H.f.* | ,, | |
| 144. Pomaderris elliptica, *Lab.* Ch. | Australia, New Zealand | Australia, New Zealand. |
| 145. Pomaderris *discolor, *Vent.* | ,, | |
| 146. Pomaderris ferruginea, *Fenzl* | ,, | |
| 147. Pomaderris apetala, *Lab.* Ch. | ,, | |
| 148. Pomaderris racemosa, *Hook.* | Tasmania. | |
| 149. Pomaderris ericæfolia, *Hook.* | New Zealand. | |

XXV. *Stackhousieæ.*

| | | |
|---|---|---|
| 150. Stackhousia monogyna, *Lab.* Ch. | Australia | Aust., N. Zeal., Philippines. |
| 151. Stackhousia *Gunnii, *H.f.* Ch. | ,, | |
| 152. Stackhousia maculata, *Sieb.* | ,, | |
| 153. Stackhousia flava, *H.f.* | Australia ? | |

## XXVI. *Leguminosæ.*

PODALYRIEÆ.

| | Distribution of Species. | Distr. of Genera or representatives. |
|---|---|---|
| 154. Oxylobium arborescens, *Br.* Ch. | Australia | Australia. |
| 155. Oxylobium ellipticum, *Br.* Ch. | Tasmania. | |
| 156. Gompholobium latifolium, *Sm.* | Australia | Australia. |
| 157. Daviesia umbellulata, *Sm.* Ch. | „ | Australia. |
| 158. Daviesia latifolia, *Br.* Ch. | „ | |
| 159. Aotis villosa, *Curt.* Ch. | „ | Australia. |
| 160. Sphærolobium vimineum, *Sm.* Ch. | „ | Australia. |
| 161. Dillwynia glaberrima, *Sm.* Ch. | Australia | Australia. |
| 162. Dillwynia floribunda, *Sims* | „ | |
| 163. Dillwynia cinerascens, *Br.* Ch. | „ | |
| 164. Pultenæa daphnoides, *Ser.* | „ | Australia. |
| 165. Pultenæa stricta, *Sims* | „ | |
| 166. Pultenæa subumbellata, *Hook.* | „ | |
| 167. Pultenæa *selaginoides, *H.f.* | Tasmania. | |
| 168. Pultenæa *pimeleoides, *H.f.* | „ | |
| 169. Pultenæa Gunnii, *Benth.* Ch. | „ | |
| 170. Pultenæa dentata, *Lab.* Ch. | Australia. | |
| 171. Pultenæa prostrata, *Benth.* | „ | |
| 172. Pultenæa Hibbertioides, *H.f.* | „ | |
| 173. Pultenæa juniperina, *Lab.* Ch. | „ | |
| 174. Pultenæa *cordata, *Hook.* | „ | |
| 175. Pultenæa diffusa, *H.f.* | Tasmania. | |
| 176. Pultenæa pedunculata, *Hook.* | Australia. | |
| 177. Pultenæa humilis, *Benth.* | Tasmania. | |
| 178. Pultenæa tenuifolia, *Br.* Ch. | Australia. | |
| 179. Pultenæa fasciculata, *Benth.* Ch. | „ (subalp.). | |
| 180. Pultenæa *Bæckioides, *Benth.* | „ | |

GENISTEÆ.

| | | |
|---|---|---|
| 181. Hovea purpurea, *Sweet* | Australia | Australia. |
| 182. Hovea heterophylla, *A. C.* Ch. | „ | |
| 183. Bossiæa ensata, *Lab.* Ch. | „ | Australia. |
| 184. Bossiæa prostrata, *Br.* | „ | |
| 185. Bossiæa cordigera, *Benth.* Ch. | Tasmania. | |
| 186. Bossiæa cinerea, *Br.* | Australia. | |
| 187. Platylobium triangulare, *Br.* | „ | Australia. |
| 188. Platylobium Murrayanum, *Hook.* | „ | |
| 189. Ptalylobium formosum, *Sm.* | „ | |
| 190. Goodia lotifolia, *Sal.* Ch. | „ | Australia. |
| 191. Goodia *pubescens, *Sims.* Ch. | „ | |

TRIFOLIEÆ.

| | | |
|---|---|---|
| 192. Lotus corniculatus, *L.* Ch. | Australia, Europe | Europe, etc. |
| 193. Lotus australis, *Andr.* | „ Polynesia. | |

GALEGEÆ.

| | Distribution of Species. | Distr. of Genera or representatives. |
|---|---|---|
| 194. Psoralea Gunnii, *H.f.* | Australia | S. Amer. (India, S. Afric.). |
| 195. Indigofera australis, *Willd.* Ch. | „ | Tropics. |
| 196. Swainsonia Lessertiæfolia, *DC.* | „ | Australia. |
| 197. Hardenbergia ovata, *Benth.* | „ | Australia. |

HEDYSAREÆ.

| | | |
|---|---|---|
| 198. Desmodium Gunnii, *Benth.* Ch. | Australia | Tropics. |
| 199. Kennedya prostrata, *Br.* Ch. | „ | Australia. |
| 200. Leptocyamus Tasmanicus, *Benth.* | „ | Australia. |
| 201. Leptocyamus clandestinus, *Benth.* Ch. | „ | |

MIMOSEÆ.

| | | |
|---|---|---|
| 202. Acacia Gunnii, *Benth.* Ch. | Australia | The phyllodineous species are chiefly Australian. |
| 203. Acacia Stuartiana, *F. Mull.* Ch. | „ | |
| 204. Acacia diffusa, *Lindl.* | Tasmania. | |
| 205. Acacia juniperina, *Willd.* | Australia. | |
| 206. Acacia ovoidea, *Benth.* | „ | |
| 207. Acacia verticillata, *Willd.* Ch. | „ | |
| 208. Acacia Riceana, *Henslow* | „ | |
| 209. Acacia axillaris, *Benth.* | Tasmania. | |
| 210. Acacia myrtifolia, *Willd.* Ch. | Australia. | |
| 211. Acacia suaveolens, *Willd.* | „ | |
| 212. Acacia crassiuscula, *Wendl.* | „ | |
| 213. Acacia verniciflua, *A. C.* | „ | |
| 214. Acacia stricta, *Willd.* Ch. | „ | |
| 215. Acacia melanoxylon, *Br.* Ch. | „ | |
| 216. Acacia linearis, *Sims.* | „ | |
| 217. Acacia mucronata, *Willd.* | „ | |
| 218. Acacia Sophoræ, *Br.* | „ | |
| 219. Acacia discolor, *Willd.* | „ | |
| 220. Acacia dealbata, *Lind.* Ch. | „ | |
| 221. Acacia mollissima, *Wild.* | „ | |

XXVII. *Rosaceæ.*

| | | |
|---|---|---|
| 222. Rubus macropodus, *Ser.* Ch. | Australia | Europe, etc. |
| 223. Rubus Gunnianus, *Hook.* Ch. | Tasmania (alpine). | |
| 224. Potentilla anserina, *L.* Ch. | Australia (ubiquitous) | Europe, etc. |
| 225. Acæna Sanguisorbæ, *Vahl.* Ch. | „ N. Zeal., Antarct. | Aust., N. Zeal., S. Af., Ant. |
| 226. Acæna ovina, *A. C.* | „ | |
| 227. Geum urbanum, *L.* Ch. | Aust., Eur., N. Zeal., Ant. | Europe, etc. |
| 228. Geum reniforme, *Muell.* | Tasmania (alpine). | |

XXVIII. *Onagrarieæ.*

| | | |
|---|---|---|
| 229. Epilobium tenuipes, *H.f.* | Tasmania (alpine) | Europe, etc. |
| 230. Epilobium pallidiflorum, *Sol.* Ch. | New Zealand. | |
| 231. Epilobium *Billardierianum, *Ser. MS.* Ch. | Australia, New Zealand. | |
| 232. Epilobium tetragonum, *L.* Ch. | Austr., N. Zeal., Ant., Eur. | |

| | Distribution of Species. | Distr. of Genera or representatives. |
|---|---|---|
| 233. Epilobium *glabellum, *Forst.* Ch | New Zealand. | |
| 234. Epilobium *junceum, *Forst.* Ch. | Austral., N. Zeal., S. Amer. | |
| 235. Œnothera Tasmanica, *H.f.* | Tasmania (alpine) | America. |

XXIX. *Halorageæ.*

| | | |
|---|---|---|
| 236. Haloragis pinnatifida, *A. Gray* Ch. | Australia | South temperate zone. |
| 237. Haloragis Gunnii, *H.f.* Ch. | „ | |
| 238. Haloragis tetragyna, *H.f.* Ch. | „ New Zealand. | |
| 239. Haloragis *depressa, *A. Cunn.* Ch. | „ „ | |
| 240. Haloragis micrantha, *Th.* Ch. | Aust., N. Zeal., Japan, Bengal. | |
| 241. Myriophyllum elatinoides, *Gaud.* | Australia, N. Zeal., Antarct. | Europe, etc. |
| 242. Myriophyllum variæfolium, *H.f.* Ch. | „ „ | |
| 243. Myriophyllum amphibium, *Lab.* | „ | |
| 244. Myriophyllum pedunculatum, *H.f.* Ch. | „ | |
| 245. Myriophyllum integrifolium, *H.f.* | „ | |
| 246. Ceratophyllum demersum, *L.* | „ ubiquitous | Europe, etc. |
| 247. Meionectes Brownii, *H.f.* | „ | Australia. |
| 248. Callitriche verna, *L.* Ch. | „ ubiquitous | Europe, etc. |
| 249. Gunnera cordifolia, *H.f.* | Tasmania (alpine) | New Zealand, Antarctic. |

XXX. *Lythrarieæ.*

| | | |
|---|---|---|
| 250. Lythrum Salicaria, *L.* Ch. | Australia, Europe | Europe, etc. |
| 251. Lythrum hyssopifolium, *L.* | Aust., Eur., S. Afr., S. Am. | |

XXXI. *Myrtaceæ.*

| | | |
|---|---|---|
| 252. Calycothrix glabra, *Br.* | Australia | Australia. |
| 253. Thryptomene micrantha, *H.f.* | Tasmania | Australia. |
| 254. Melaleuca squamea, *Lab.* | Australia | Australia, India. |
| 255. Melaleuca pustulata, *H.f.* | Tasmania. | |
| 256. Melaleuca ericæfolia, *Sm.* | Australia. | |
| 257. Melaleuca squarrosa, *Sm.* | „ | |
| 258. Melaleuca gibbosa, *Lab.* | „ | |
| 259. Kunzea corifolia, *Rich.* | „ | Australia. |
| 260. Callistemon viridiflorum, *DC.* Ch. | „ | Australia. |
| 261. Callistemon salignum, *DC.* Ch. | „ | |
| 262. Eucalyptus cordata, *Lab.* | Tasmania | Australia, Malay Islands. |
| 263. Eucalyptus Risdoni, *H.f.* | „ | |
| 264. Eucalyptus Globulus, *Lab.* | Australia. | |
| 265. Eucalyptus coccifera, *H.f.* | Tasmania (subalp.) | |
| 266. Eucalyptus urnigera, *H.f.* | „ „ | |
| 267. Eucalyptus viminalis, *Lab.* Ch. | Australia. | |
| 268. Eucalyptus Gunnii, *H.f.* Ch. | „ (subalp.) | |
| 269. Eucalyptus Acervula, *Sieb.* | „ | |
| 270. Eucalyptus vernicosa, *H.f.* | Tasmania (alpine). | |
| 271. Eucalyptus amygdalina, *Lab.* Ch. | Australia. | |
| 272. Eucalyptus coriacea, *A. Cunn.* | „ | |

| | | Distribution of Species. | Distr. of Genera or representatives. |
|---|---|---|---|
| 273. | Eucalyptus gigantea, *H.f.* Ch. | Australia. | |
| 274. | Eucalyptus radiata, *Sieb.* Ch. | ,, | |
| 275. | Eucalyptus nitida, *H.f.* | Tasmania. | |
| 276. | Leptospermum scoparium, *Sm.* | Australia, New Zealand | Australia, N. Zeal., Borneo. |
| 277. | Leptospermum lanigerum, *Sm.* Ch. | ,, | |
| 278. | Leptospermum *flavescens, *Sm.* Ch. | ,, | |
| 279. | Leptospermum nitidum, *H.f.* | Tasmania. | |
| 280. | Leptospermum *rupestre, *H.f.* Ch. | ,, (alpine). | |
| 281. | Leptospermum myrtifolium, *Sieb.* Ch. | Australia. | |
| 282. | Fabricia lævigata, *Gærtn.* | ,, | Australia. |
| 283. | Bæckia leptocaulis, *H.f.* | Tasmania | Australia, China, Malay. |
| 284. | Bæckia *thymifolia, *H.f.* Ch. | ,, | |
| 285. | Bæckia diffusa, *Sieb.* | Australia. | |
| 286. | Bæckia Gunniana, *Schauer.* Ch. | Tasmania (alpine). | |

XXXII. *Cucurbitaceæ.*

| | | | |
|---|---|---|---|
| 287. | Sicyos angulatus, *L.* | Aust., N. Zeal., N. & S. Am. | Trop. Amer. and Polynesia. |

XXXIII. *Portulaceæ.*

| | | | |
|---|---|---|---|
| 288. | Calandrinia calyptrata, *H.f.* Ch. | Australia | America. |
| 289. | Claytonia Australasica, *Hook.* Ch. | ,, New Zealand | America. |
| 290. | Montia fontana, *L.* | N. Zeal., Europe, Antarct. | Europe. |

XXXIV. *Crassulaceæ.*

| | | | |
|---|---|---|---|
| 291. | Tillæa verticillaris, *DC.* Ch. | Australia, N. Zeal., S. Africa | Europe, etc. |
| 292. | Tillæa purpurata, *H.f.* | ,, | |
| 293. | Tillæa macrantha, *H.f.* | ,, | |
| 294. | Tillæa recurva, *H.f.* | ,, | |

XXXV. *Ficoideæ.*

| | | | |
|---|---|---|---|
| 295. | Mesembryanthemum æquilaterale, *Ait.* | Australia | South Africa. |
| 296. | Mesembryanthemum australe, *Sol.* | ,, New Zealand. | |
| 297. | Tetragonia expansa, *Sol.* | Aust., N. Zeal., S. Am., Japan. | S. Ocean, Japan. |
| 298. | Tetragonia implexicoma, *H.f.* | Australia, New Zealand. | |

XXXVI. *Cunoniaceæ.*

| | | | |
|---|---|---|---|
| 299. | Anodopetalum biglandulosum, *A. C.* Ch. | Tasmania (subalp.) | Tasmania. |
| 300. | Bauera rubioides, *Andr.* Ch. | Australia | Australia. |
| 301. | Bauera *microphylla, *Sieb.* | ,, | |
| 302. | ? Tetracarpæa Tasmanica, *H.f.* Ch. | Tasmania (alpine) | Tasmania. |

XXXVII. *Escallonieæ.*

| | | | |
|---|---|---|---|
| 303. | Anopterus glandulosus, *Lab.* Ch. | Tasmania (subalp.) | Australia. |

XXXVIII. *Umbelliferæ.*

| | | | |
|---|---|---|---|
| 304. | Hydrocotyle Asiatica, *L.* Ch. | Aust., N. Zeal., Tropics, etc. | Europe, etc. |
| 305. | Hydrocotyle hirta, *Br.* Ch. | Australia. | |

| | Distribution of Species. | Distr. of Genera or representatives. |
|---|---|---|
| 306. Hydrocotyle peduncularis, *Br.* Ch. | Australia. | |
| 307. Hydrocotyle *Tasmanica, *H.f.* Ch. | ,, | |
| 308. Hydrocotyle vagans, *H.f.* Ch. | ,, | |
| 309. Hydrocotyle pterocarpa, *Mull.* | ,, | |
| 310. Hydrocotyle tripartita, *Br.* Ch. | ,, | |
| 311. Hydrocotyle muscosa, *Br.* | ,, | |
| 312. Didiscus pilosus, *Benth.* | ,, | Aust., N. Caledon., Borneo. |
| 313. Didiscus humilis, *H.f.* Ch. | ,, (subalp.). | |
| 314. Xanthosia montana, *Sieb.* Ch. | ,, | Australia. |
| 315. Xanthosia dissecta, *H.f.* | ,, | |
| 316. Xanthosia pusilla, *Bunge* | ,, | |
| 317. Diplaspis Hydrocotyle, *H.f.* Ch. | ,, (alpine) | Australia. |
| 318. Diplaspis cordifolia, *H.f.* | Tasmania (subalp.). | |
| 319. Dichopetalum ranunculaceum, *Mull.* | Australia (subalp.) | Tasmania. |
| 320. Hemiphues bellidioides, *H.f.* | Tasmania (alpine) | Tasmania. |
| 321. Microsciadium Saxifraga, *H.f.* | ,, (subalp.) | Tasmania. |
| 322. Gingidium procumbens, *Muell.* | ,, (alpine) | New Zealand. |
| 323. Eryngium vesiculosum, *Lab.* | ,, New Zealand | Europe. |
| 324. Crantzia lineata, *Nutt.* Ch. | Aust., N. Zeal., Amer., Ant. | America, Antarctic. |
| 325. Apium australe, *Pet. Th.* | ,, ,, Antarctic | Europe. |
| 326. Daucus brachiatus, *Sieb.* | ,, ,, N. & S. Amer. | Europe. |
| 327. Oreomyrrhis eriopoda, *H.f.* Ch. | Australia | N. Zeal., S. America, Ant. |
| 328. Oreomyrrhis brachycarpa, *H.f.* Ch. | Tasmania (subalp.). | |
| 329. Oreomyrrhis argentea, *H.f.* | ,, ,, | |
| 330. Oreomyrrhis sessiliflora, *H.f.* | ,, (alpine). | |
| 331. Oreomyrrhis ciliata, *H.f.* Ch. | ,, (subalp.). | |

XXXIX. *Araliaceæ.*

| | | |
|---|---|---|
| 332. Panax Gunnii, *H.f.* | Tasmania | India, etc. |

XL. *Caprifoliaceæ.*

| | | |
|---|---|---|
| 333. Sambucus Gaudichaudiana, *DC.* Ch. | Australia | Europe, etc. |

XLI. *Rubiaceæ.*

| | | |
|---|---|---|
| 334. Coprosma hirtella, *Lab.* Ch. | Australia | Aust., N. Zeal., Polynesia. |
| 335. Coprosma Billardieri, *H.f.* Ch. | ,, | |
| 336. Coprosma nitida, *H.f.* Ch. | Tasmania (subalp.). | |
| 337. Coprosma pumila, *H.f.* Ch. | Australia, N. Zealand (alp.). | |
| 338. Opercularia ovata, *H.f.* Ch. | ,, | Australia. |
| 339. Opercularia varia, *H.f.* Ch. | ,, | |
| 340. Nertera depressa, *B. & S.* Ch. | Aust., N. Z., Ant., S. Am. (alp.) | America, Antarctic. |
| 341. Asperula subsimplex, *H.f.* | Tasmania | Europe, etc. |
| 342. Asperula Gunnii, *H.f.* Ch. | Australia (subalp.). | |
| 343. Asperula scoparia, *H.f.* Ch. | ,, | |
| 344. Asperula conferta, *H.f.* | ,, | |
| 345. Asperula pusilla, *H.f.* | Tasmania (alpine). | |

| | Distribution of Species. | Distr. of Genera or representatives. |
|---|---|---|
| 346. Asperula minima, *H.f.* | Tasmania. | |
| 347. Galium vagans, *H.f.* Ch. | Australia | Europe, etc. |
| 348. Galium ciliare, *H.f.* Ch. | " | |
| 349. Galium australe, *DC.* Ch. | " | |
| 350. Galium *squalidum, *H.f.* | " | |
| 351. Galium albescens, *H.f.* | Tasmania. | |

XLII. *Compositæ.*

| | | |
|---|---|---|
| 352. Eurybia argophylla, *Cass.* Ch. | Australia | Australia, New Zealand. |
| 353. Eurybia viscosa, *Cass.* Ch. | " | |
| 354. Eurybia erubescens, *DC.* Ch | " | |
| 355. Eurybia myrsinoides, *DC.* Ch. | " | |
| 356. Eurybia Persoonioides, *DC.* Ch. | Tasmania (subalp.). | |
| 357. Eurybia alpina, *H.f.* Ch. | " (alpine). | |
| 358. Eurybia obcordata, *H.f.* Ch. | " " | |
| 359. Eurybia *lirata, *DC.* Ch. | Australia. | |
| 360. Eurybia fulvida, *Cass.* | Tasmania. | |
| 361. Eurybia *Gunniana, *DC.* Ch. | Australia. | |
| 362. Eurybia pinifolia, *H.f.* Ch. | Tasmania (subalp.). | |
| 363. Eurybia ledifolia, *A. C.* Ch. | " (alpine). | |
| 364. Eurybia linearifolia, *DC.* | Australia. | |
| 365. Eurybia ramulosa, *DC.* Ch. | " | |
| 366. Eurybia lepidophylla, *DC.* Ch. | " | |
| 367. Eurybia floribunda, *H.f.* | " | |
| 368. Eurybia glandulosa, *DC.* Ch. | " | |
| 369. Eurybia linifolia, *H.f.* | Tasmania. | |
| 370. Eurybia ericoides, *Steetz* | " | |
| 371. Eurybia ciliata, *Benth.* | Australia. | |
| 372. Celmisia longifolia, *Cass.* Ch. | " (subalp.) | Australia, N. Zeal., Antarc. |
| 373. Vittadinia scabra, *DC.* | " | Australia, New Zealand. |
| 374. Vittadinia cuneata, *DC.* Ch. | " | |
| 375. Erigeron Pappochroma, *Lab.* Ch. | Tasmania (alpine) | Europe, etc. |
| 376. Erigeron Tasmanicum, *H.f.* Ch. | " " | |
| 377. Erigeron *Gunnii, *Muell.* Ch. | " (subalp.). | |
| 378. Brachycome decipiens, *H.f.* Ch. | Australia | Australia, New Zealand. |
| 379. Brachycome tenuiscapa, *H.f.* Ch. | " (subalp.). | |
| 380. Brachycome radicans, *Steetz* Ch. | " | |
| 381. Brachycome linearifolia, *DC.* Ch. | " | |
| 382. Brachycome scapiformis, *DC.* Ch. | " | |
| 383. Brachycome *parvula, *H.f.* | Tasmania. | |
| 384. Brachycome *pumila, *Walp.* | " | |
| 385. Brachycome angustifolia, *A. Cunn.* | Australia. | |
| 386. Brachycome stricta, *DC.* Ch. | " | |
| 387. Brachycome oblongifolia, *Benth.* | Tasmania. | |
| 388. Brachycome diversifolia, *Fisch.* Ch | Australia. | |
| 389. Brachycome ciliaris, *Less.* | " | |

| | Distribution of Species. | | Distr. of Genera or representativ… |
|---|---|---|---|
| 390. Paquerina graminea, *Cass.* Ch. | Australia | | Australia. |
| 391. Lagenophora Billardieri, *Cass.* Ch. | „ | India, Japan | Aust., N.Z., Ind., Ant., Am. |
| 392. Lagenophora latifolia, *H.f.* Ch. | Tasmania (subalp.). | | |
| 393. Lagenophora *montana, *H.f.* Ch. | „ | „ | |
| 394. Lagenophora Gunniana, *Steetz* Ch. | Australia. | | |
| 395. Lagenophora Emphysopus, *H.f.* | „ | | |
| 396. Nablonium calyceroides, *Cass.* | „ | | Australia. |
| 397. Cotula coronopifolia, *Linn.* | „ | N. Zeal., Afr., Eur. | Europe, etc. |
| 398. Cotula australis, *H.f.* | „ | „ S. Africa. | |
| 399. Cotula integrifolia, *H.f.* | Tasmania. | | |
| 400. Cotula alpina, *H.f.* Ch. | Australia (subalp.). | | |
| 401. Leptinella longipes, *H.f.* Ch. | „ | | S. Amer., Austr., Antarctic. |
| 402. Leptinella intricata, *H.f.* Ch. | „ | | |
| 403. Leptinella Filicula, *H.f.* Ch. | „ | (subalp.). | |
| 404. Myriogyne minuta, *Less.* Ch. | „ | N. Zeal., Asia, Afr. | Tropics. |
| 405. Scleroleima Forsteroides, *H.f.* Ch. | Tasmania (alpine) | | Tasmania. |
| 406. Trineuron scapigerum, *Muell.* | „ | „ | N. Zealand, Austr., Ant. |
| 407. Calocephalus lacteus, *Br.* | „ | | Australia. |
| 408. Leucophyta Brownei, *Less.* | „ | | „ |
| 409. Craspedia Richea, *Cass.* Ch. | „ | New Zealand | Australia, New Zealand. |
| 410. Craspedia *macrocephala, *Hook.* Ch. | „ | | |
| 411. Craspedia *alpina, *Back.* Ch. | „ | (alpine). | |
| 412. Skirrhophorus eriocephalus, *H.f.* Ch. | „ | | Australia. |
| 413. Actinopappus perpusillus, *H.f.* | „ | | „ |
| 414. Pumilo Preissii, *Sond.* | „ | | „ |
| 415. Apalochlamys Billardieri, *DC.* | „ | | „ |
| 416. Cassinia aculeata, *Br.* Ch. | „ | | Austr., N. Zeal., N. Caled. |
| 417. Ozothamnus Hookeri, *Sonder.* Ch. | „ | (subalp.) | Australia, New Zealand. |
| 418. Ozothamnus lycopodioides, *H.f.* | Tasmania. | | |
| 419. Ozothamnus selaginoides, *Sonder* | „ | (subalp.). | |
| 420. Ozothamnus scutellifolius, *H.f.* | „ | | |
| 421. Ozothamnus obcordatus, *DC.* Ch. | Australia. | | |
| 422. Ozothamnus reticulatus, *DC.* | „ | | |
| 423. Ozothamnus cinereus, *Br.* | „ | | |
| 424. Ozothamnus bracteolatus, *H.f.* | Tasmania. | | |
| 425. Ozothamnus Antennaria, *H.f.* Ch. | „ | (subalp.). | |
| 426. Ozothamnus Backhousii, *H.f.* | „ | „ | |
| 427. Ozothamnus ledifolius, *H.f.* | „ | „ | |
| 428. Ozothamnus ericæfolius, *H.f.* | „ | „ | |
| 429. Ozothamnus rosmarinifolius, *Br.* Ch. | Australia. | | |
| 430. Ozothamnus Gunnii, *H.f.* | Tasmania. | | |
| 431. Ozothamnus thyrsoideus, *DC.* Ch. | „ | | |
| 432. Ozothamnus ferrugineus, *Br.* Ch. | Australia. | | |
| 433. Raoulia catipes, *H.f.* Ch. | „ | (alpine) | New Zealand. |
| 434. Pterygopappus Lawrencei, *H.f.* Ch. | Tasmania (alpine) | | Tasmania. |
| 435. Leptorhynchus squamatus, *Juss.* Ch. | Australia | | Australia. |

| | Distribution of Species. | Distr. of Genera or representatives. |
|---|---|---|
| 436. Leptorhynchus elongatus, *DC.* | Australia. | |
| 437. Podolepis acuminata, *Br.* Ch. | " | Australia. |
| 438. Millotia tenuifolia, *Cass.* | " | Australia. |
| 439. Helichrysum bracteatum, *Willd.* Ch. | " | Aust., N. Zeal., S. Afr., Eur. |
| 440. Helichrysum scorpioides, *Lab.* Ch. | " | |
| 441. Helichrysum semipapposum, *DC.* Ch. | " | |
| 442. Helichrysum apiculatum, *DC.* Ch. | " | |
| 443. Helichrysum papillosum, *Lab.* | " | |
| 444. Helichrysum leucopsideum, *DC.* | " | |
| 445. Helichrysum dealbatum, *Lab.* Ch. | " | |
| 446. Helichrysum pumilum, *H.f.* | Tasmania (subalp.). | |
| 447. Helichrysum Milligani, *H.f.* | " " | |
| 448. Helipterum incanum, *DC.* | Australia | Australia, South Africa. |
| 449. Helipterum anthemoides, *DC.* Ch. | " | |
| 450. Gnaphalium luteo-album, *L.* | " (ubiquitous). | Europe, etc. |
| 451. Gnaphalium involucratum, *Forst.* Ch. | " New Zealand. | |
| 452. Gnaphalium collinum, *Lab.* Ch. | " | |
| 453. Gnaphalium *alpigenum, *Muell.* Ch. | " (alpine). | |
| 454. Gnaphalium indutum, *H.f.* | " | |
| 455. Gnaphalium ? Planchoni, *H.f.* Ch. | Tasmania (alpine). | |
| 456. Erechtites prenanthoides, *DC.* | Australia, New Zealand | Australia, New Zealand. |
| 457. Erechtites arguta, *DC.* | " " | |
| 458. Erechtites quadridenta, *DC.* Ch. | " " | |
| 459. Erechtites hispidula, *DC.* Ch. | " " | |
| 460. Erechtites Gunnii, *H.f.* Ch. | Tasmania (subalp.). | |
| 461. Senecio lautus, *Forst.* Ch. | Australia, New Zealand | Europe, etc. |
| 462. Senecio capillifolius, *H.f.* | Tasmania. | |
| 463. Senecio pectinatus, *DC.* Ch. | " (subalp.). | |
| 464. Senecio leptocarpus, *DC.* Ch. | " " | |
| 465. Senecio spathulatus, *A. Rich.* | Australia. | |
| 466. Senecio velleioides, *A. C.* Ch. | " | |
| 467. Senecio australis, *Willd.* Ch. | " | |
| 468. Senecio odoratus, *Horn.* | " | |
| 469. Senecio Georgianus, *DC.* | " | |
| 470. Senecio primulifolius, *Muell.* | Tasmania (alpine). | |
| 471. Senecio papillosus, *Muell.* | " (alpine). | |
| 472. Bedfordia salicina, *DC.* Ch. | Australia | Australia. |
| 473. Bedfordia linearis, *DC.* | Tasmania (subalp.). | |
| 474. Centropappus Brunonis, *H.f.* | " " | Australia. |
| 475. Cymbonotus Lawsonianus, *Cass.* | Australia | Cape Affinity. |
| 476. Microseris Forsteri, *H.f.* Ch. | " New Zealand | South America. |
| 477. Picris hieracioides, *L.* | " " Eur. | Europe. |
| 478. Sonchus asper, *Fuchs.* Ch. | " (ubiquitous) | Europe. |

XLIII. *Brunoniaceæ.*

| | | |
|---|---|---|
| 479. Brunonia australis, *Linn.* | Australia | Australia. |

### XLIV. *Goodeniaceæ.*

| | Distribution of Species. | Distr. of Genera or representatives. |
|---|---|---|
| 480. Dampiera stricta, *Br.* | Australia | Australia. |
| 481. Scævola Hookeri, *Muell.* Ch. | " (subalp.). | India, etc. |
| 482. Selliera radicans, *Cav.* | " N. Zeal., Antarc. | |
| 483. Goodenia ovata, *Sm.* Ch. | " | Australia. |
| 484. Goodenia geniculata, *Br.* | " | |
| 485. Goodenia hederacea, *Sm.* Ch. | " | |
| 486. Goodenia elongata, *Lab.* Ch. | " | |
| 487. Goodenia humilis, *Br.* | " | |
| 488. Velleia paradoxa, *Br.* Ch. | " | Australia. |
| 489. Velleia montana, *H.f.* Ch. | " (subalp.). | |

### XLV. *Stylideæ.*

| | | |
|---|---|---|
| 490. Stylidium graminifolium, *Sw.* Ch. | Australia | Australia, India. |
| 491. Stylidium despectum, *Br.* | " | |
| 492. Stylidium perpusillum, *H.f.* | Tasmania. | |
| 493. Forsterà bellidifolia, *Hook.* | " (alpine) | Australia, New Zealand. |

### XLVI. *Lobeliaceæ.*

| | | |
|---|---|---|
| 494. Lobelia anceps, *Th.* | Aust., N. Zl., S. Af., S. Am. | Europe, etc. |
| 495. Lobelia surrepens, *H.f.* Ch. | Tasmania (subalp.). | |
| 496. Lobelia pedunculata, *Br.* Ch. | Australia. | |
| 497. Lobelia fluviatilis, *Br.* Ch. | " | |
| 498. Lobelia irrigua, *Br.* | " | |
| 499. Lobelia gibbosa, *Lab.* Ch. | " | |

### XLVII. *Campanulaceæ.*

| | | |
|---|---|---|
| 500. Wahlenbergia gracilis, *A. DC.* Ch. | Australia, N. Zeal., India | South Africa. |
| 501. Wahlenbergia *saxicola, *A. DC.* Ch. | New Zealand (alpine). | |

### XLVIII. *Ericeæ.*

| | | |
|---|---|---|
| 502. Gaultheria hispida, *Br.* Ch. | Australia (subalp.) | India, America. |
| 503. Gaultheria *lanceolata, *H.f.* | Tasmania (alpine). | |
| 504. Gaultheria antipoda, var. $\gamma$, *H.f.* Ch. | New Zealand (alpine). | |
| 505. Pernettya Tasmanica, *H.f.* Ch. | Tasmania (alpine) | Antarctic, S. America. |

### XLIX. *Epacrideæ.*

| | | |
|---|---|---|
| 506. Styphelia adscendens, *Br.* | Australia | Australia. |
| 507. Astroloma humifusum, *Br.* Ch. | " | Australia. |
| 508. Stenanthera pinifolia, *Br.* | " | Australia. |
| 509. Cyathodes glauca, *Lab.* | Tasmania | Aust., N. Zeal., Poly. |
| 510. Cyathodes straminea, *Br.* | " (alpine). | |
| 511. Cyathodes *macrantha, *H.f.* Ch. | " " | |
| 512. Cyathodes dealbata, *Br.* Ch. | " " | |

| | Distribution of Species. | Distr. of Genera or representatives. |
|---|---|---|
| 513. Cyathodes adscendens, *H.f.* Ch. . . . | Tasmania (alpine). | |
| 514. Cyathodes divaricata, *H.f.* . . . . . | Australia. | |
| 515. Cyathodes parvifolia, *Br.* Ch. . . . . | Tasmania. | |
| 516. Cyathodes Oxycedrus, *Br.* Ch. . . . | „ New Zealand. | |
| 517. Cyathodes abietina, *Br.* . . . . . . . | „ | |
| 518. Lissanthe strigosa, *Br.* Ch. . . . . | Australia . . . . . . . | Australia. |
| 519. Lissanthe montana, *Br.* . . . . . . . | „ (subalp.). | |
| 520. Lissanthe daphnoides, *Br.* . . . . . . | „ | |
| 521. Lissanthe ciliata, *Br.* Ch. . . . . . | „ | |
| 522. Leucopogon Richei, *Br.* . . . . . . . | „ . . . . . . . | Aust., N. Zeal., Malay Isls. |
| 523. Leucopogon affinis, *Br.* . . . . . . . | „ | |
| 524. Leucopogon australis, *Br.* . . . . . . | „ | |
| 525. Leucopogon virgatus, *Br.* Ch. . . . | „ | |
| 526. Leucopogon ericoides, *Br.* Ch. . . . | „ | |
| 527. Leucopogon collinus, *Br.* Ch. . . . | „ | |
| 528. Leucopogon *ciliatus, *A. C.* Ch. . . . | „ | |
| 529. Leucopogon Hookeri, *Sond.* Ch. . . | „ (alpine). | |
| 530. Leucopogon Frazeri, *A. C.* Ch. . . . | „ New Zealand. | |
| 531. Monotoca lineata, *Br.* Ch. . . . . | „ . . . . . . . | Australia. |
| 532. Monotoca empetrifolia, *Br.* Ch. . . . | Tasmania (alpine). | |
| 533. Acrotriche serrulata, *Br.* Ch. . . . . | Australia . . . . . . . | Australia. |
| 534. Acrotriche *patula, *Br.* . . . . . . . | „ | |
| 535. Decaspora disticha, *Br.* . . . . . . . | Tasmania . . . . . . . | Australia. |
| 536. Decaspora Cunninghamii, *DC.* Ch. . . | „ | |
| 537. Decaspora Gunnii, *H.f.* . . . . . . . | „ | |
| 538. Decaspora thymifolia, *Br.* Ch. . . . | „ (alpine). | |
| 539. Pentachondra involucrata, *Br.* Ch. . . | „ „ . . . | Australia, New Zealand. |
| 540. Pentachondra ericæfolia, *H.f.* . . . . | „ „ | |
| 541. Pentachondra pumila, *Br.* Ch. . . . | Australia (alpine), N. Zeal. | |
| 542. Pentachondra verticillata, *H.f.* . . . | Tasmania „ | |
| 543. Epacris *Gunnii, *H.f.* Ch. . . . . . | Australia (subalp.) . . . | Australia, New Zealand. |
| 544. Epacris impressa, *Lab.* Ch. . . . . | „ | |
| 545. Epacris *ceræflora, *Grah.* . . . . . | „ | |
| 546. Epacris *ruscifolia, *Br.* . . . . . . | „ | |
| 547. Epacris lanuginosa, *Lab.* Ch. . . . . | „ | |
| 548. Epacris mucronulata, *Br.* . . . . . | Tasmania. | |
| 549. Epacris heteronema, *Lab.* . . . . . | Australia (subalp.). | |
| 550. Epacris squarrosa, *H.f.* . . . . . . | Tasmania. | |
| 551. Epacris myrtifolia, *Lab.* . . . . . . . | „ | |
| 552. Epacris *serpyllifolia, *Br.* Ch. . . . | Australia (alpine). | |
| 553. Epacris *exserta, *Br.* Ch. . . . . . | Tasmania. | |
| 554. Epacris *virgata, *H.f.* . . . . . . . | „ | |
| 555. Epacris obtusifolia, *Sm.* . . . . . . | Australia. | |
| 556. Epacris *Franklinii, *H.f.* . . . . . | Tasmania. | |
| 557. Epacris *corymbiflora, *H.f.* . . . . | „ | |
| 558. Epacris petrophila, *H.f.* . . . . . . | Australia (alpine). | |

| | Distribution of Species. | Distr. of Genera or representatives. |
|---|---|---|
| 559. Prionotes cerinthoides, *Br.* | Tasmania (subalp.) | Tasmania, South America. |
| 560. Archeria hirtella, *H.f.* | „ | Tasmania. |
| 561. Archeria eriocarpa, *H.f.* Ch. | „ | |
| 562. Archeria serpyllifolia, *H.f.* | „ (alpine). | |
| 563. Archeria *minor, *H.f.* | „ „ | |
| 564. Sprengelia incarnata, *Sm.* Ch. | Australia | Australia. |
| 565. Sprengelia *propinqua, *A. C.* Ch. | Tasmania (subalp.). | |
| 566. Sprengelia *montana, *Br.* Ch. | „ (alpine). | |
| 567. Cystanthe Sprengelioides, *Br.* Ch. | „ „ | Tasmania. |
| 568. Cystanthe procera, *Muell.* | „ | |
| 569. Pilitis acerosa, *Lind.* Ch. | „ (alpine) | Tasmania. |
| 570. Pilitis Milligani, *H.f.* | „ „ | |
| 571. Richea pandanifolia, *H.f.* | „ (subalp.) | Australia. |
| 572. Richea dracophylla, *Br.* | „ „ | |
| 573. Richea Gunnii, *H.f.* Ch. | Australia (alpine). | |
| 574. Richea *scoparia, *H.f.* Ch. | Tasmania „ | |
| 575. Dracophyllum Milligani, *H.f.* | „ „ | Aust., N. Zeal., N. Caled. |
| 576. Dracophyllum minimum, *Muell.* | „ „ | |

L. *Oleaceæ.*

| | | |
|---|---|---|
| 577. Notelæa ligustrina, *Vent.* Ch. | Australia | Australia. |

LI. *Apocryneæ.*

| | | |
|---|---|---|
| 578. Alyxia buxifolia, *Br.* | Australia | India. |
| 579. Lyonsia straminea, *Br.* Ch. | Australia | New Caledonia. |

LII. *Gentianeæ.*

| | | |
|---|---|---|
| 580. Sebæa ovata, *Br.* Ch. | Australia, New Zealand | South Africa. |
| 581. Sebæa albidiflora, *Muell.* | „ | |
| 582. Erythræa australis, *Br.* | Australia | Europe, etc. |
| 583. Gentiana montana, *Forst.* Ch. | „ New Zealand | Europe, etc. |
| 584. Gentiana Diemensis, *Griseb.* Ch. | „ (subalp.). | |
| 585. Villarsia parnassiifolia, *Br.* Ch. | „ | Europe, etc. |
| 586. Villarsia exigua, *Muell.* | „ ? | |
| 587. Liparophyllum Gunnii, *H.f.* | Tasmania (alp.), I. of Pines | Europe, etc. |

LXIII. *Loganiaceæ.*

| | | |
|---|---|---|
| 588. Mitrasacme paradoxa, *Br.* Ch. | Australia | India. |
| 589. Mitrasacme distylis, *Hook.* | „ | |
| 590. Mitrasacme serpyllifolia, *Br.* Ch. | „ | |
| 591. Mitrasacme pilosa, *Lab.* Ch. | „ | |
| 592. Mitrasacme montana, *H.f.* | Tasmania (alpine). | |
| 593. Mitrasacme Archeri, *H.f.* Ch. | „ „ | |

LIV. *Convolvulaceæ.*

| | | |
|---|---|---|
| 594. Convolvulus erubescens, *Sims* | Australia, N. Zeal., Europe | Europe, etc. |

| | Distribution of Species. | Distr. of Genera or representatives. |
|---|---|---|
| 595. Calystegia Sepium, *Br.* | Aust., N. Z., Ant., Eur., Ind. | Europe, etc. |
| 596. Calystegia Soldanella, *Br.* | „ „ Eur., N. & S. Am. | |
| 597. Wilsonia humilis, *Br.* | Australia | Australia. |
| 598. Wilsonia Backhousiana, *H.f.* Ch. | „ | |
| 599. Dichondra repens, *Forst.* Ch. | Aust., N. Z., India, S. Af., N & S. Am. | |
| 600. Cuscuta australis, *Br.* | Australia, New Zealand | Europe, etc. |

## LV. *Boragineæ.*

| | | |
|---|---|---|
| 601. Myosotis australis, *Br.* Ch. | Australia, New Zealand ? | Europe, etc. |
| 602. Myosotis suaveolens, *Br.* Ch. | „ | |
| 603. Cynoglossum australe, *Br.* Ch. | „ | Europe, etc. |
| 604. Cynoglossum suaveolens, *Br.* Ch. | „ | |
| 605. Cynoglossum latifolium, *Br.* | „ | |

## LXVI. *Labiatæ.*

| | | |
|---|---|---|
| 606. Mentha australis, *Br.* | Australia | Europe, etc. |
| 607. Mentha gracilis, *Br.* Ch. | Tasmania. | |
| 608. Mentha *serpyllifolia, *Benth.* | „ | |
| 609. Lycopus australis, *Br.* Ch. | Australia | Europe, etc. |
| 610. Prunella vulgaris, *Linn.* Ch. | „ | Europe, etc. |
| 611. Scutellaria humilis, *Br.* Ch. | „ | Europe, etc. |
| 612. Prostanthera lasianthos, *Br.* Ch. | „ | Australia. |
| 613. Prostanthera rotundifolia, *Br.* | „ | |
| 614. Prostanthera retusa, *Br.* | „ | |
| 615. Westringia rubiæfolia, *Br.* | Tasmania | Australia. |
| 616. Westringia brevifolia, *Benth.* Ch. | „ | |
| 617. Westringia angustifolia, *Br.* | Australia. | |
| 618. Teucrium corymbosum, *Br.* Ch. | „ | Europe, etc. |
| 619. Ajuga australis, *Br.* | „ | Europe, etc. |

## LVII. *Myoporineæ.*

| | | |
|---|---|---|
| 620. Myoporum Tasmanicum, *DC.* | Australia | Australia, Pacific. |

## LVIII. *Solaneæ.*

| | | |
|---|---|---|
| 621. Solanum nigrum, *Linn.* | Australia (ubiquitous). | |
| 622. Solanum aviculare, *Forst.* Ch. | „ New Zealand ? | |

## LIX. *Scrophularineæ.*

| | | |
|---|---|---|
| 623. Anthocercis Tasmanica, *H.f.* | Tasmania | Australia. |
| 624. Mimulus repens, *Br.* | Australia, New Zealand | America, India. |
| 625. Mazus Pumilio, *Br.* Ch. | „ „ | India. |
| 626. Gratiola pubescens, *Br.* Ch. | „ „ | America, Asia. |
| 627. Gratiola latifolia, *Br.* Ch. | „ | |
| 628. Gratiola *nana, *Benth.* Ch. | Tasmania (alpine). | |
| 629. Glossostigma elatinoides, *Benth.* | Australia, New Zealand | Asia, South Africa. |

| | Distribution of Species. | Distr. of Genera or representatives. |
|---|---|---|
| 630. Limosella aquatica, *Linn.* | Aust., N. Zeal., Ant. (ubiq.) | Europe, etc. |
| 631. Veronica formosa, *Br.* | Tasmania | Europe, etc. |
| 632. Veronica labiata, *Br.* Ch. | Australia. | |
| 633. Veronica nivea, *Lindl.* Ch. | „ (subalp.). | |
| 634. Veronica calycina, *Br.* Ch. | „ | |
| 635. Veronica distans, *Br.* | „ | |
| 636. Veronica arguta, *Br.* | „ (subalp.). | |
| 637. Veronica gracilis, *Br.* Ch. | „ | |
| 638. Ourisia integrifolia, *Br.* Ch. | Tasmania (alpine) | New Zealand, Antarctic. |
| 639. Euphrasia *alpina, *Br.* Ch. | Australia (alpine) | Europe, etc. |
| 640. Euphrasia *collina, *Br.* Ch. | „ | |
| 641. Euphrasia multicaulis, *Benth.* Ch. | „ | |
| 642. Euphrasia scabra, *Br.* Ch. | „ | |
| 643. Euphrasia striata, *Br.* Ch. | Tasmania (alpine). | |
| 644. Euphrasia cuspidata, *H.f.* Ch. | „ „ | |

LX. *Lentibularineæ.*

| | | |
|---|---|---|
| 645. Utricularia australis, *Br.* Ch. | Australia | Europe, etc. |
| 646. Utricularia dichotoma, *Lab.* Ch. | „ | |
| 647. Utricularia *uniflora, *Br.* | „ | |
| 648. Utricularia lateriflora, *Br.* | „ | |
| 649. Utricularia monanthos, *H.f.* | Tasmania (alpine). | |
| 650. Polypompholyx tenella, *Lab.* | Australia | Australia. |

LXI. *Primulaceæ.*

| | | |
|---|---|---|
| 651. Samolus litoralis, *Br.* | Australia, N. Zeal., S. Amer. | Europe, etc. |

LXII. *Plumbagineæ.*

| | | |
|---|---|---|
| 652. Statice australis, *Spr.* | Australia. | Europe, etc. |

LXIII. *Plantagineæ.*

| | | |
|---|---|---|
| 653. Plantago varia, *Br.* Ch. | Australia | Europe, etc. |
| 654. Plantago bellidioides, *Dcne.* Ch. | Tasmania (subalp.). | |
| 655. Plantago antarctica, *Dcne.* Ch. | „ „ | |
| 656. Plantago Archeri, *H.f.* Ch. | „ (alpine). | |
| 657. Plantago Tasmanica, *H.f.* Ch. | „ „ | |
| 658. Plantago Brownii, *Rich.* | Australia, N. Zeal., Antarct. | |
| 659. Plantago paradoxa, *Nob.* Ch. | Tasmania (alpine). | |
| 660. Plantago Gunnii, *Nob.* Ch. | „ „ | |

LXIV. *Polygoneæ.*

| | | |
|---|---|---|
| 661. Rumex Brownii, *Campd.* | Australia | Europe, etc. |
| 662. Rumex bidens, *Br.* | „ | |
| 663. Polygonum minus, *Huds.* | „ N. Zeal., Europe | Europe, etc. |
| 664. Polygonum subsessile, *Br.* | „ | |
| 665. Polygonum strigosum, *Br.* | „ | |

| | | Distribution of Species. | | Distr. of Genera or representatives. |
|---|---|---|---|---|
| 666. | Polygonum prostratum, *Br.* Ch. | Australia. | | |
| 667. | Muehlenbeckia adpressa, *Meisn.* Ch. | ,, | N. Zeal. | Aust., Pacific, S. America. |
| 668. | Muehlenbeckia axillaris, *H.f.* | ,, | ,, (subalp.). | |

### LXV. *Phytolacceæ.*

| | | | | |
|---|---|---|---|---|
| 669. | Didymotheca thesioides, *H.f.* | Australia | | Australia. |

### LXVI. *Amarantaceæ.*

| | | | | |
|---|---|---|---|---|
| 670. | Trichinium spathulatum, *Br.* | Australia | | Australia. |
| 671. | Alternanthera sessilis, *Br.* | ,, | N. Zeal. (ubiq.) | Tropics. |
| 672. | Hemichroa pentandra, *Br.* | ,, | | Australia. |

### LXVII. *Chenopodiaceæ.*

| | | | | |
|---|---|---|---|---|
| 673. | Rhagodia baccata, *Moq.* | Australia | | Australia. |
| 674. | Rhagodia nutans, *Br.* | ,, | | |
| 675. | Chenopodium glaucum, *Linn.* | ,, | N. Zeal., Ant., Europe | Europe, etc. |
| 676. | Chenopodium erosum, *Br.* | ,, | | |
| 677. | Atriplex cinerea, *Poir.* | ,, | N. Zealand | Europe, etc. |
| 678. | Atriplex patula, *Linn.* | ,, | ,, Europe. | |
| 679. | Atriplex Billardieri, *H.f.* | ,, | ,, | |
| 680. | Threlkeldia diffusa, *Br.* | ,, | | Australia. |
| 681. | Suæda maritima, *Dun.* | ,, | N. Zealand (ubiq.) | Europe, etc. |
| 682. | Salicornia Arbuscula, *Br.* | ,, | ,, Tropics | Europe, etc. |
| 683. | Salicornia Indica, *Willd.* | ,, | ,, ,, | |

### LXVIII. *Laurineæ.*

| | | | | |
|---|---|---|---|---|
| 684. | Cassytha melantha, *Br.* Ch. | Australia | | Tropics. |
| 685. | Cassytha pubescens, *Br.* Ch. | ,, | | |
| 686. | Cassytha glabella, *Br.* | ,, | | |

### LXIX. *Proteaceæ.*

| | | | | |
|---|---|---|---|---|
| 687. | Conospermum taxifolium, *Sm.* | Australia | | Australia. |
| 688. | Isopogon ceratophyllus, *Br.* | ,, | | Australia. |
| 689. | Agastachys odorata, *Br.* | Tasmania | | Tasmania. |
| 690. | Cenarrhenes nitida, *Lab.* | ,, | | Tasmania. |
| 691. | Persoonia juniperina, *Lab.* Ch. | Australia | | Australia, New Zealand. |
| 692. | Persoonia Gunnii, *H.f.* Ch. | Tasmania (subalp.). | | |
| 693. | Bellendena montana, *Br.* Ch. | ,, | (alpine) | Tasmania. |
| 694. | Grevillea australis, *Br.* Ch. | Australia | | Australia, New Caledonia. |
| 695. | Hakea Epiglottis, *Lab.* | Australia | | Australia. |
| 696. | Hakea pugioniformis, *Cav.* | ,, | | |
| 697. | Hakea microcarpa, *Br.* Ch. | ,, | | |
| 698. | Hakea acicularis, *Br.* | ,, | | |
| 699. | Hakea lissosperma, *Br.* Ch. | Tasmania (subalp.). | | |
| 700. | Orites diversifolia, *Br.* | ,, | (alpine) | Tasmania, (Australia.) |

| | Distribution of Species. | | Distr. of Genera or representative. |
|---|---|---|---|
| 701. Orites Milligani, *Meisn.* | Tasmania | (alpine). | |
| 702. Orites revoluta, *Br.* Ch. | „ | „ | |
| 703. Orites acicularis, *Br.* Ch. | „ | „ | |
| 704. Telopea truncata, *Br.* Ch. | „ | (subalp.) | Australia. |
| 705. Lomatia polymorpha, *Br.* | „ | „ | Australia, South America. |
| 706. Lomatia tinctoria, *Br.* Ch. | „ | | |
| 707. Banksia media, *Br.* | „ | | Australia. |
| 708. Banksia australis, *Br.* Ch. | „ | | |

## LXX. *Thymeleæ.*

| | | | |
|---|---|---|---|
| 709. Drapetes Tasmanica, *H.f.* Ch. | Australia | (alpine) | N. Zeal., Fuegia, Borneo. |
| 710. Pimelea filiformis, *H.f.* | Tasmania | | Australia, New Zealand. |
| 711. Pimelea gracilis, *Br.* Ch. | Australia. | | |
| 712. Pimelea drupacea, *Lab.* Ch. | „ | | |
| 713. Pimelea Gunnii, *H.f.* Ch. | Tasmania | (subalp.). | |
| 714. Pimelea nivea, *Lab.* Ch. | „ | „ | |
| 715. Pimelea sericea, *Br.* Ch. | „ | „ | |
| 716. Pimelea cinerea, *Br.* | „ | | |
| 717. Pimelea ligustrina, *Lab.* Ch. | Australia. | | |
| 718. Pimelea flava, *Br.* Ch. | „ | | |
| 719. Pimelea cernua, *Br.* Ch. | „ | | |
| 720. Pimelea *linifolia, *Sm.* | „ | | |
| 721. Pimelea glauca, *Br.* | „ | | |
| 722. Pimelea humilis, *Br.* | „ | | |
| 723. Pimelea pauciflora, *Br.* Ch. | „ | | |
| 724. Pimelea pygmæa, *Muell.* Ch. | Tasmania | (alpine). | |

## LXXI. *Santalaceæ.*

| | | | |
|---|---|---|---|
| 725. Exocarpus cupressiformis, *Lab.* | Australia | | Australia. |
| 726. Exocarpus stricta, *Br.* Ch. | „ | | |
| 727. Exocarpus humifusa, *Br.* Ch. | Aust. (alp.), N. Zl., Sandw. Isls.? | | |
| 728. Leptomeria Billardieri, *Br.* Ch. | Australia | | Australia. |
| 729. Leptomeria glomerata, *Muell.* | Tasmania. | | |
| 730. Thesium australe, *Br.* Ch. | Australia | | Europe, etc. |

## LXXII. *Euphorbiaceæ.*

| | | | |
|---|---|---|---|
| 731. Ricinocarpus pinifolius, *Desf.* | Australia | | Australia. |
| 732. Beyeria oblongifolia, *H.f.* Ch. | „ | | Australia. |
| 733. Beyeria *Backhousii, *H.f.* | „ | | |
| 734. Bertya rosmarinifolia, *Pl.* | „ | | Australia. |
| 735. Amperea spartioides, *Brong.* Ch. | „ | | Australia. |
| 736. Phyllanthus Gunnii, *H.f.* Ch. | „ | | India, etc. |
| 737. Phyllanthus australis, *H.f.* Ch. | „ | | |
| 738. Micranthea hexandra, *H.f.* Ch. | „ | | Australia. |
| 739. Poranthera microphylla, *Brongn.* Ch. | „ | | Australia. |

### LXXIII. *Urticeæ.*

| | Distribution of Species. | Distr. of Genera or representatives. |
|---|---|---|
| 740. Urtica incisa, *Poir.* Ch. | New Zealand | Europe, etc. |
| 741. Parietaria debilis, *Forst.* Ch. | ubiquitous | Europe, etc. |
| 742. Australina pusilla, *Gaud.* Ch. | Australia, New Zealand | Australia, New Zealand. |

### LXXIV. *Cupuliferæ.*

| | | |
|---|---|---|
| 743. Fagus Cunninghamii, *Hook.* Ch. | Australia | Eur., N. Zl., S. Am., Antar. |
| 744. Fagus Gunnii, *H.f.* | Tasmania (alpine). | |

### LXXV. *Casuarineæ.*

| | | |
|---|---|---|
| 745. Casuarina quadrivalvis, *Lab.* | Australia | Australia, India, etc. |
| 746. Casuarina distyla, *Vent.* | " | |
| 747. Casuarina *suberosa, *Ott. & Diet.* Ch. | " | |

### LXXVI. *Coniferæ.*

| | | |
|---|---|---|
| 748. Frenela rhomboidea, *Endl.* | Australia | Australia. |
| 749. Frenela *australis, *Endl.* | Tasmania. | |
| 750. Diselma Archeri, *H.f.* Ch. | " (subalp.) | Tasmania. |
| 751. Athrotaxis cupressioides, *Don.* Ch. | " " | Tasmania. |
| 752. Athrotaxis selaginoides, *Don.* Ch. | " " | |
| 753. Athrotaxis laxifolia, *Hook.* Ch. | " " | |
| 754. Pherosphæra Hookeriana, *Arch.* | " (alpine) | Tasmania. |
| 755. Podocarpus alpina, *Br.* Ch. | Australia (subalp.) | India, etc. |
| 756. Dacrydium Franklinii, *H.f.* | Tasmania | N. Zealand, etc. |
| 757. Microcachrys tetragona, *H.f.* Ch. | " (alpine) | Tasmania. |
| 758. Phyllocladus rhomboidalis, *Rich.* Ch. | " (subalp.) | New Zealand, Borneo. |

## MONOCOTYLEDONES.

### I. *Orchideæ.*

| | | |
|---|---|---|
| 1. Thelymitra antennifera, *H.f.* | Australia | Aus., N. Zl., Java, Antarc. |
| 2. Thelymitra Smithiana, *H.f.* | " | |
| 3. Thelymitra venosa, *Br.* Ch. | " | |
| 4. Thelymitra carnea, *Br.* Ch. | " | |
| 5. Thelymitra nuda, *Br.* Ch. | " (New Zealand ?) | |
| 6. Thelymitra angustifolia, *Br.* Ch. | " | |
| 7. Thelymitra ixioides, *Br.* Ch. | " | |
| 8. Diuris maculata, *Sm.* Ch. | " | Australia. |
| 9. Diuris palustris, *Lindl.* | " | |
| 10. Diuris sulphurea, *Br.* Ch. | " | |
| 11. Diuris corymbosa, *Lindl.* | " | |
| 12. Diuris pedunculata, *Br.* Ch. | " | |
| 13. Cryptostylis longifolia, *Br.* Ch. | " | Australia. |
| 14. Prasophyllum australe, *Br.* | " | Australia. |

| | Distribution of Species. | Distr. of Genera or representatives. |
|---|---|---|
| 15. Prasophyllum lutescens, *Lindl.* Ch. | Australia. | |
| 16. Prasophyllum brevilabre, *H.f.* Ch. | ,, | |
| 17. Prasophyllum *flavum, *Br.* Ch. | ,, | |
| 18. Prasophyllum patens, *Br.* Ch. | ,, | |
| 19. Prasophyllum *truncatum, *Lindl.* Ch. | ,, | |
| 20. Prasophyllum alpinum, *Br.* Ch. | ,, (subalp.). | |
| 21. Prasophyllum *fuscum, *Br.* Ch. | ,, | |
| 22. Prasophyllum brachystachyum, *Lindl.* | ,, | |
| 23. Prasophyllum nudiscapum, *H.f.* | Tasmania. | |
| 24. Prasophyllum despectans, *H.f.* Ch. | ,, | |
| 25. Prasophyllum Archeri, *H.f.* Ch. | ,, | |
| 26. Prasophyllum nudum, *H.f.* Ch. | ,, New Zealand. | |
| 27. Calochilus campestris, *Br.* | Australia | Australia. |
| 28. Spiranthes australis, *Lindl.* Ch. | Aus., N.Z., China, Ind., Siber. | Europe, etc. |
| 29. Corysanthes fimbriata, *Br.* Ch. | ,, | Australia, Java. |
| 30. Lyperanthus nigricans, *Br.* | ,, | Australia, New Zealand. |
| 31. Burnettia cuneata, *Lindl.* | Tasmania | Tasmania. |
| 32. Caleana major, *Br.* Ch. | Australia | Australia. |
| 33. Caleana minor, *Br.* | ,, | |
| 34. Pterostylis curta, *Br.* | ,, | Australia, New Zealand. |
| 35. Pterostylis nutans, *Br.* Ch. | ,, | |
| 36. Pterostylis pedunculata, *Br.* Ch. | Tasmania. | |
| 37. Pterostylis nana, *Br.* Ch. | Australia. | |
| 38. Pterostylis obtusa, *Br.* Ch. | Tasmania. | |
| 39. Pterostylis cucullata, *Br.* Ch. | ,, | |
| 40. Pterostylis *dubia, *Br.* Ch. | ,, | |
| 41. Pterostylis furcata, *Lindl.* Ch. | ,, | |
| 42. Pterostylis squamata, *Br.* | Australia, New Zealand. | |
| 43. Pterostylis mutica, *Br.* | ,, | |
| 44. Pterostylis rufa, *Br.* | ,, | |
| 45. Pterostylis præcox, *Lindl.* | ,, | |
| 46. Pterostylis aphylla, *Lindl.* Ch. | ,, | |
| 47. Pterostylis parviflora, *Br.* Ch. | ,, | |
| 48. Pterostylis longifolia, *Br.* Ch. | ,, | |
| 49. Chiloglottis diphylla, *Br.* Ch. | ,, | New Zealand, Antarctic. |
| 50. Chiloglottis Gunnii, *Lindl.* Ch. | ,, | |
| 51. Microtis pulchella, *Br.* | ,, | Aust., N. Zeal., Java. |
| 52. Microtis *arenaria, *Br.* | ,, | |
| 53. Microtis rara, *Br.* Ch. | Aust., N. Zl., Java, N. Caled., Bonin. | |
| 54. Microtis *parviflora, *Br.* Ch. | Australia. | |
| 55. Acianthus caudatus, *Br.* Ch. | ,, | Aust., N. Zl., Antarct. |
| 56. Acianthus exsertus, *Br.* Ch. | ,, | |
| 57. Acianthus viridis, *H.f.* | Tasmania. | |
| 58. Cyrtostylis reniformis, *Br.* Ch. | Australia | Australia, New Zealand. |
| 59. Eriochilus autumnalis, *Br.* Ch. | ,, | Australia. |
| 60. Caladenia Menziesii, *Br.* | ,, | Australia. New Zealand. |

| | Distribution of Species. | Distr. of Genera or representatives. |
|---|---|---|
| 61. Caladenia filamentosa, *Br.* Ch. | Australia. | |
| 62. Caladenia dilatata, *Br.* Ch. | " | |
| 63. Caladenia clavigera, *A. C.* Ch. | " | |
| 64. Caladenia Patersoni, *Br.* Ch. | " | |
| 65. Caladenia *pallida, *Lindl.* | " | |
| 66. Caladenia latifolia, *Br.* | " | |
| 67. Caladenia barbata, *Lindl.* | " | |
| 68. Caladenia cærulea, *Br.* | " | |
| 69. Caladenia carnea, *Br.* Ch. | " | |
| 70. Caladenia congesta, *Br.* Ch. | " | |
| 71. Caladenia alata, *Br.* Ch. | " | |
| 72. Caladenia *angustata, *Lindl.* Ch. | " | |
| 73. Glossodia major, *Br.* Ch. | " | Australia. |
| 74. Gastrodia sesamoides, *Br.* Ch. | " | Australia, New Zealand. |
| 75. Dipodium punctatum, *Br.* Ch. | " | Australia, New Caledonia. |
| 76. Gunnia australis, *Lindl.* | " | Australia. |
| 77. Dendrobium Milligani, *Muell.* | Tasmania | India, etc. |
| 78. Dendrobium, sp.? | " | |

II. *Irideæ.*

| | | |
|---|---|---|
| 79. Patersonia glauca, *Br.* Ch. | Australia | Australia. |
| 80. Patersonia longiscapa, *Sweet* | " | |
| 81. Diplarrhena Moræa, *Br.* Ch. | " | Australia. |
| 82. Libertia Lawrencii, *H.f.* Ch. | " (subalp.). | Australia, N. Zeal., Chili. |

III. *Hæmodoraceæ.*

| | | |
|---|---|---|
| 83. Hæmodorum distichophyllum, *Hook.* | Tasmania (alpine). | Australia. |

IV. *Hypoxideæ.*

| | | |
|---|---|---|
| 84. Hypoxis hygrometrica, *Lab.* | Australia | India and S. Africa. |
| 85. Hypoxis glabella, *Br.* Ch. | " | |
| 86. Hypoxis pusilla, *H.f.* | " | |

V. *Hydrocharideæ.*

| | | |
|---|---|---|
| 87. Vallisneria spiralis, *L.* | Australia (ubiquitous). | Warm latitudes. |

VI. *Pistiaceæ.*

| | | |
|---|---|---|
| 88. Lemna minor, *L.* | Australia (ubiquitous). | Ubiquitous. |
| 89. Lemna trisulca, *L.* | " | " |

VII. *Typhaceæ.*

| | | |
|---|---|---|
| 90. Typha angustifolia, *L.* | Australia (ubiquitous). | Ubiquitous. |

VIII. *Alismaceæ.*

| | | |
|---|---|---|
| 91. Triglochin triandrum, *Muell.* Ch. | Aust., N.Z., S.Af., N. & S.Am. | Europe, etc. |
| 92. Triglochin centrocarpum, *Hook.* | Australia. | |

| | Distribution of Species. | Distr. of Genera or representatives. |
|---|---|---|
| 93. Triglochin procerum, *Br.* Ch. | Australia | |
| 94. Potamogeton natans, *L.* Ch. | ,, (ubiquitous). | Europe, etc. |
| 95. Potamogeton heterophyllus, *Schreb.* Ch. | ,, ,, | |
| 96. Potamogeton gramineus, *L.* Ch. | ,, ,, | |
| 97. Ruppia maritima, *L.* | ,, (ubiquitous). | Europe, etc. |
| 98. Zannichellia Preissii, *Lehm.* | ,, | Europe, etc. |
| 99. Posidonia australis, *H.f.* | ,, | Oceans, warm and tropical. |
| 100. Cymodocea antarctica, *H.f.* | ,, | Oceans, warm and tropical. |
| 101. Zostera marina, *L.?* | ,, (ubiquitous). | Europe, etc. |
| 102. Halophila ovalis, *Gaud.* | ,, India, Africa | Tropical seas. |

IX. *Melanthaceæ.*

| | | |
|---|---|---|
| 103. Burchardia umbellata, *Br.* | Australia | Australia. |
| 104. Anguillaria dioica, *Br.* | ,, | Australia. |
| 105. Anguillaria uniflora, *Br.* Ch. | ,, | |
| 106. Hewardia Tasmanica, *Hook.* | Tasmania (subalp.) | Tasmania. |
| 107. Campynema linearis, *Lab.* | ,, ,, | Tasmania. |

X. *Smilaceæ.*

| | | |
|---|---|---|
| 108. Drymophila cyanocarpa, *Br.* Ch. | Australia | Tasmania. |

XI. *Liliaceæ.*

| | | |
|---|---|---|
| 109. Blandfordia grandiflora, *Br.* Ch. | Australia | Australia. |
| 110. Arthropodium paniculatum, *Br.* | ,, | Australia, New Zealand. |
| 111. Arthropodium pendulum, *DC.* | Tasmania. | |
| 112. Arthropodium minus, *Br.* | Australia. | |
| 113. Arthropodium laxum, *Sieb.* | ,, | |
| 114. Arthropodium strictum, *Br.* | Tasmania. | |
| 115. Bulbine bulbosa, *Haw.* | Australia | Australia, S. Africa. |
| 116. Bulbine semibarbata, *Haw.* | ,, | |
| 117. Cæsia corymbosa, *Br.* | ,, | Australia. |
| 118. Cæsia parviflora, *Br.* | ,, | |
| 119. Cæsia vittata, *Br.* | ,, | |
| 120. Cæsia? alpina, *H.f.* Ch. | Tasmania. | |
| 121. Thysanotus Patersoni, *Br.* | Australia | Australia. |
| 122. Herpolirion Tasmaniæ, *H.f.* Ch. | ,, (alpine) | Australia, New Zealand. |
| 123. Tricoryne elatior, *Br.* | ,, | Australia. |
| 124. Stypandra cæspitosa, *Br.* | ,, | Australia, New Caledonia. |
| 125. Stypandra umbellata, *Br.* | ,, | |
| 126. Dianella cærulea, *Sims.* Ch. | ,, | Aust., India, N. Z., S. Afr. |
| 127. Dianella longifolia, *Br.* | ,, | |
| 128. Dianella lævis, *Br.* | ,, | |
| 129. Dianella revoluta, *Br.* Ch. | ,, | |
| 130. Dianella Tasmanica, *H.f.* Ch. | ,, | |
| 131. Dianella Archeri, *H.f.* Ch. | Tasmania. | |

| | Distribution of Species. | Distr. of Genera or representatives. |
|---|---|---|
| 132. Xanthorrhœa australis, *Br.* | Australia | Australia. |
| 133. Xanthorrhœa hastilis, *Br.* | „ | |
| 134. Xanthorrhœa minor, *Br.* | „ | |
| 135. Laxmannia minor, *Br.* | „ | Australia (Timor). |
| 136. Astelia alpina, *Br.* Ch. | „ (alpine). | New Zealand, Polynesia. |
| 137. Astelia stylosa, *Muell.* | Tasmania (alpine). | |
| 138. Milligania longifolia, *H.f.* | „ (subalpine). | Tasmania. |
| 139. Milligania densiflora, *H.f.* | „ (subalpine). | |

XII. *Junceæ.*

| | | |
|---|---|---|
| 140. Xerotes longifolia, *Br.* Ch. | Australia | Australia. |
| 141. Xerotes glauca, *Br.* | „ | |
| 142. Juncus planifolius, *Br.* Ch. | Aust., N. Zl., Chili, Antarc. | All temperate latitudes. |
| 143. Juncus cæspiticius, *Meyer.* Ch. | Australia (subalp.). | |
| 144. Juncus falcatus, *Meyer.* Ch. | „ „ | |
| 145. Juncus bufonius, *L.* Ch. | „ (ubiquitous). | |
| 146. Juncus revolutus, *Br.* | „ | |
| 147. Juncus capillaceus, *H.f.* Ch. | „ N. Zeal. (alpine). | |
| 148. Juncus Holoschœnus, *Br.* Ch. | „ „ Europe. | |
| 149. Juncus maritimus, *Lamk.* | „ (ubiquitous). | |
| 150. Juncus australis, *H.f.* | „ New Zealand. | |
| 151. Juncus *pallidus, *Br.* Ch. | „ | |
| 152. Juncus communis, *Meyer.* Ch. | „ (ubiquitous). | |
| 153. Juncus pauciflorus, *Br.* Ch. | „ | |
| 154. Juncus *Gunnii, *H.f.* | Tasmania. | |
| 155. Juncus vaginatus, *Br.* | Australia, New Zealand. | |
| 156. Luzula campestris, *Sm.* Ch. | „ (ubiquitous). | Europe, etc. |
| 157. Luzula *Oldfieldii, *H.f.* | Tasmania (alpine). | |

XIII. *Xyrideæ.*

| | | |
|---|---|---|
| 158. Xyris operculata, *Lab.* Ch. | Australia | America, India. |
| 159. Xyris gracilis, *Br.* | „ | |

XIV. *Restiaceæ.*

| | | |
|---|---|---|
| 160. Restio monocephalus, *Br.* Ch. | Australia | Australia, South Africa. |
| 161. Restio complanatus, *Br.* | „ | |
| 162. Restio australis, *Br.* | „ (subalp.). | |
| 163. Restio gracilis, *Br.* | „ | |
| 164. Restio tetraphyllus, *Lab.* Ch. | „ | |
| 165. Lepyrodia Tasmanica, *H.f.* | Tasmania | Australia. |
| 166. Leptocarpus Brownii, *H.f.* Ch. | Australia | Australia, New Zealand. |
| 167. Leptocarpus tenax, *Br.* Ch. | „ | |
| 168. Hypolæna fastigiata, *Br.* Ch. | „ | Australia. |
| 169. Calorophus elongata, *Lab.* Ch. | „ New Zealand | Australia, New Zealand. |
| 170. Aphelia Gunnii, *H.f.* | „ | Australia. |
| 171. Aphelia Pumilio, *H.f.* | „ | |

| | Distribution of Species. | Distr. of Genera or representatives. |
|---|---|---|
| 172. Centrolepis aristata, *H.f.* | Australia | Australia. |
| 173. Centrolepis tenuior, *R. & S.* | „ | |
| 174. Centrolepis fascicularis, *Lab.* | „ | |
| 175. Centrolepis pulvinata, *R. & S.* | „ | |
| 176. Alepyrum monogynum, *H.f.* | Tasmania (subalp.) | Australia, New Zealand. |
| 177. Alepyrum muscoides, *H.f.* | Australia „ | |
| 178. Alepyrum Muelleri, *H.f.* | „ | |
| 179. Alepyrum polygynum, *Br.* | „ | |
| 180. Trithuria submersa, *H.f.* | „ | Australia. |

XV. *Cyperaceæ.*

| | | |
|---|---|---|
| 181. Cyperus sanguineo-fuscus, *Nees* | Tasmania | All warm latitudes. |
| 182. Cyperus Gunnii, *H.f.* | Australia. | |
| 183. Schœnus fluitans, *H.f.* | Tasmania | Europe, etc. |
| 184. Chætospora tenuissima, *H.f.* | Australia | Europe, etc. |
| 185. Chætospora capillacea, *H.f.* Ch. | Tasmania. | |
| 186. Chætospora nitens, *Br.* | Australia, New Zealand. | |
| 187. Chætospora imberbis, *Br.* Ch. | „ „ | |
| 188. Chætospora axillaris, *Br.* Ch. | „ „ | |
| 189. Gymnoschœnus sphærocephalus, *H.f.* Ch. | „ | Australia. |
| 190. Chorizandra enodis, *Nees* | „ | Australia. |
| 191. Carpha alpina, *Br.* Ch. | „ N. Zeal. (alp.) | Aust., N. Zeal., Antarct. |
| 192. Elæocharis sphacelata, *Br.* Ch. | „ N. Zeal., Pacific | Ubiquitous. |
| 193. Elæocharis gracilis, *Br.* Ch. | „ „ | |
| 194. Isolepis fluitans, *Br.* Ch. | „ (ubiquitous) | Ubiquitous. |
| 195. Isolepis *crassiuscula, *H.f.* Ch. | South Africa? (alp.). | |
| 196. Isolepis lenticularis, *Br.* | Australia. | |
| 197. Isolepis *alpina, *H.f.* | Tasmania (alpine). | |
| 198. Isolepis prolifer, *Br.* Ch. | Aust., N. Zeal., S. Africa. | |
| 199. Isolepis nodosa, *Br.* Ch. | „ „ S. Af., S. Amer. | |
| 200. Isolepis setacea, *Br.* | Australia (ubiquitous). | |
| 201. Isolepis Saviana, *Schultes* | „ „ | |
| 202. Isolepis cartilaginea, *Br.* Ch. | „ N. Zeal., S. Africa. | |
| 203. Isolepis riparia, *Br.* Ch. | „ „ „ | |
| 204. Scirpus triqueter, *L.* Ch. | „ (ubiquitous) | Ubiquitous. |
| 205. Scirpus maritimus, *L.* | „ „ | |
| 206. Scirpus lacustris, *L.* | „ „ | |
| 207. Lepidosperma gladiata, *Lab.* | „ | Australia, New Zealand. |
| 208. Lepidosperma elatior, *Lab.* Ch. | „ | |
| 209. Lepidosperma longitudinalis, *Lab.* | „ | |
| 210. Lepidosperma Oldfieldii, *H.f.* | Tasmania. | |
| 211. Lepidosperma concava, *Br.* | Australia, New Zealand. | |
| 212. Lepidosperma *lateralis, *Br.* | „ | |
| 213. Lepidosperma *angustifolia, *H.f.* | Tasmania. | |
| 214. Lepidosperma linearis, *Br.* | Australia. | |
| 215. Lepidosperma squamata, *Lab.* | Tasmania. | |

| | Distribution of Species. | Distr. of Genera or representatives. |
|---|---|---|
| 216. Lepidosperma globosa, *Lab.* | Tasmania. | |
| 217. Lepidosperma tetragona, *Lab.* | „ New Zealand. | |
| 218. Lepidosperma filiformis, *Lab.* | Australia (subalp.). | |
| 219. Oreobolus Pumilio, *Br.* Ch. | „ N. Zeal. (alp.) | Aust., N. Zeal., Ant. Amer. |
| 220. Cladium glomeratum, *Br.* | „ | Australia, Europe, etc. |
| 221. Cladium laxiflorum, *H.f.* | Tasmania. | |
| 222. Cladium junceum, *Br.* Ch. | Australia, New Zealand. | |
| 223. Cladium Gunnii, *H.f.* | „ ? | |
| 224. Cladium tetraquetrum, *H.f.* Ch. | „ | |
| 225. Cladium schœnoides, *Br.* Ch. | „ | |
| 226. Cladium Filum, *Br.* | „ | |
| 227. Cladium Mariscus, *Br.* | „ (ubiquitous). | |
| 228. Gahnia trifida, *Lab.* | „ | Aust. N. Zl., Pacif., Malay Isls. |
| 229. Gahnia psittacorum, *Lab.* Ch. | „ | |
| 230. Gahnia melanocarpa, *Br.* | „ | |
| 231. Caustis pentandra, *Br.* | „ | Australia. |
| 232. Carex Archeri, *Boott.* Ch. | Tasmania (alp.) | Europe, etc. |
| 233. Carex inversa, *Br.* Ch. | Australia, New Zealand. | |
| 234. Carex appressa, *Br.* | „ „ Antarct. | |
| 235. Carex chlorantha, *Br.* Ch. | „ | |
| 236. Carex Gaudichaudiana, *Kth.* Ch. | „ | |
| 237. Carex barbata, *Boott* | Tasmania. | |
| 238. Carex Gunniana, *Boott.* Ch. | Australia. | |
| 239. Carex littorea, *Lab.* | „ N. Zeal., Japan. | |
| 240. Carex Cataractæ, *Br.* Ch. | Tasmania (alpine). | |
| 241. Carex longifolia, *Br.* | Australia. | |
| 242. Carex fascicularis, *Sol.* Ch. | „ New Zealand. | |
| 243. Carex breviculmis, *Br.* Ch. | „ „ | |
| 244. Carex Bichenoviana, *Br.* | Tasmania. | |
| 245. Uncinia tenella, *Br.* Ch. | Australia | Aust., N. Zl., temp. S. Am. |
| 246. Uncinia riparia, *Br.* Ch. | Tasmania (subalp.). | |
| 247. Uncinia nervosa, *Boott* | „ | |
| 248. Uncinia compacta, *Br.* Ch. | „ (alpine). | |

XVI. *Gramineæ.*

| | | |
|---|---|---|
| 249. Tetrarhena distichophylla, *Br.* | Tasmania | Australia. |
| 250. Tetrarhena tenacissima, *Nees* | Australia. | |
| 251. Tetrarhena acuminata, *Br.* | „ | |
| 252. Microlæna Gunnii, *H.f.* Ch. | Tasmania | Australia, New Zealand. |
| 253. Microlæna stipoides, *Br.* | Australia, New Zealand. | |
| 254. Diplax Tasmanica, *H.f.* | Tasmania | Tasmania, New Zealand. |
| 255. Alopecurus geniculatus, *L.* Ch. | Aust., Eur., N. Am., N. Ind. | Europe. |
| 256. Spinifex hirsutus, *Lab.* | Australia, New Zealand | Aust., N. Zeal., India. |
| 257. Hemarthria uncinata, *Br.* | „ | Europe, etc. |
| 258. Anthistiria australis, *Br.* Ch. | „ India, Africa | India, etc. |
| 259. Hierochloe redolens, *Br.* Ch. | Aust., N. Zl., Antarc. Amer. | Europe, etc. |

| | Distribution of Species. | Distr. of Genera or representatives. |
|---|---|---|
| 260. Hierochloe borealis, *R. & S.* Ch. | N. Zealand, Europe (alp.). | |
| 261. Hierochloe rariflora, *H.f.* | Australia. | |
| 262. Stipa semibarbata, *Br.* | „ | All temperate latitudes. |
| 263. Stipa *pubescens, *Br.* | „ | |
| 264. Stipa flavescens, *Lab.* | „ | |
| 265. Stipa setacea, *Br.* | „ | |
| 266. Dichelachne crinita, *Nees.* Ch. | „ New Zealand | Australia, New Zealand. |
| 267. Dichelachne *sciurea, *H.f.* | „ „ | |
| 268. Dichelachne stipoides, *H.f.* | „ „ | |
| 269. Agrostis parviflora, *Br.* Ch. | „ „ | Europe, etc. |
| 270. Agrostis venusta, *Tr.* Ch. | „ | |
| 271. Agrostis quadriseta, *Br.* Ch. | „ New Zealand. | |
| 272. Agrostis Billardieri, *Br.* | „ „ | |
| 273. Agrostis æquata, *Nees* | Tasmania. | |
| 274. Agrostis *æmula, *Br.* Ch. | Australia, New Zealand. | |
| 275. Agrostis *scabra, *Br.* Ch. | „ (subalp.). | |
| 276. Agrostis *montana, *Br.* Ch. | „ (subalp.). | |
| 277. Agrostis contracta, *Muell.* | „ | |
| 278. Polypogon Monspeliensis, *Desv.* Ch. | „ (introduced ?) | Europe, etc. |
| 279. Echinopogon ovatus, *P. B.* Ch. | „ New Zealand | Australia, New Zealand. |
| 280. Pentapogon Billardieri, *Br.* Ch. | „ | Australia. |
| 281. Phragmites communis, *Tr.* Ch. | „ Eur., N. Asia, etc. | Europe, etc. |
| 282. Deschampsia cæspitosa, *Beauv.* Ch. | Aust., N. Zl., Eur., S. Am. | Europe, etc. |
| 283. Trisetum subspicatum, *P. B.* Ch. | Arctic and Antarctic (alp.) | Europe, etc. |
| 284. Danthonia pilosa, *Br.* | Australia, New Zealand | Australia, Europe, S. Africa. |
| 285. Danthonia semi-annularis, *Br.* Ch. | „ „ | |
| 286. Danthonia *subulata, *H.f.* Ch. | „ | |
| 287. Danthonia *setacea, *Br.* Ch. | „ | |
| 288. Danthonia pauciflora, *Br.* Ch. | „ (alpine). | |
| 289. Danthonia nervosa, *H.f.* | „ | |
| 290. Danthonia *Archeri, *H.f.* Ch. | Tasmania. | |
| 291. Glyceria fluitans, *Br.* Ch. | Australia (ubiquitous) | Europe, etc. |
| 292. Glyceria stricta, *H.f.* | „ New Zealand. | |
| 293. Poa australis, *Br.* Ch. | „ „ | Europe, etc. |
| 294. Poa tenera, *Muell.* Ch. | „ | |
| 295. Poa *affinis, *Br.* Ch. | „ New Zealand. | |
| 296. Poa *saxicola, *Br.* | Tasmania (subalp.). | |
| 297. Kœleria cristata, *Pers.* | Aust., N. Zeal. (ubiq.) | Europe, etc. |
| 298. Festuca duriuscula, *L.* | „ „ „ | Europe, etc. |
| 299. Festuca bromoides, *L.* Ch. | (introduced ?) „ | |
| 300. Festuca distichophylla, *Br.* | Australia. | |
| 301. Festuca Hookeriana, *Muell.* Ch. | „ (subalp.). | |
| 302. Festuca littoralis, *Lab.* | „ N. Zeal., Antarct. | |
| 303. Triticum scabrum, *Br.* | „ „ | |
| 304. Triticum pectinatum, *Br.* Ch. | „ | |
| 305. Triticum *velutinum, *Nees* | „ (subalp.). | |

This catalogue places in a very strong light the thoroughly Eastern Australian character of the Tasmania Flora: out of 1,063* species, only 280, or rather more than one-fourth, have not been found on the Australian continent. There are only 22 genera and 267 species noted as being absolutely peculiar to Tasmania, of which latter fully 44 will prove, in all probability, to be varieties.

The contrast between the Floras of south-west Australia and Tasmania, in respect of their affinity with that of south-east Australia, is very remarkable, for though their geographical contiguity would lead us to expect that the Tasmanian Flora should be less different from the Victorian than that of King George's Sound is, it must be recollected that Tasmania is placed several degrees further south, in a colder climate and moister atmosphere, and is separated from Victoria by a wide and deep oceanic channel.

It will probably be conceded that Tasmania once formed a continuous southward extension of Victoria, and that as Britain was peopled with continental plants before the formation of the Channel, so Tasmania and Victoria possessed their present Flora before they were separated by Bass' Straits; but if the effects of segregation and natural selection have done so little towards modifying the Floras of the opposite shores during the immense epoch that has intervened since the earliest formation of Bass' Straits, we are all the more puzzled to account for the complete change of the south-western Flora, which is isolated by no such barrier from the south-eastern.

There are only 592 flowering plants peculiar to Tasmania and Australia, or 860 if those peculiar to Tasmania are included, so that fully one-fifth of the Flora is extra-Australian; whereas only one-sixth of the south-eastern Flora and one-tenth of the south-western are extra-Australian. Considering the before-mentioned isolation of Tasmania, this is certainly a most remarkable fact, and requires a close scrutiny.

Turning to the genera again, I find that out of the whole (394), only 22 are absolutely peculiar to Tasmania; or, adding these to the 122 which are exclusively Australian and Tasmanian, I find only 144 in all. In other words, considerably more than two-thirds of the Tasmanian genera are found in other countries besides Australia; whereas in south-western Australia much less than half the genera are extra-Australian, in south-eastern somewhat more than half, and in the whole Australian Flora, between one-half and two-thirds.

In examining the distribution of the genera and species a little further, I find that the deficiency of Australian forms, and preponderance of extra-Australian, is caused partly by the paucity of new genera of Australian affinity, partly by the absence of some that are common on the north shore of Bass's Straits, but most of all by the greater proportion of New Zealand, South American, Antarctic, and even European genera and species, some of which do not occur on the Australian continent. Thus no less than 120, or nearly one-third, of the genera, and 67, or one-fifteenth, of the Tasmanian species, are European, whilst with the other quarters it stands thus:—

| | | | | | |
|---|---|---|---|---|---|
| In all Australia, | Europ. genera, | one-sixth | of the whole; | species about | one-seventieth. |
| In S.E. Australia | ,, | less than one-third | ,, | ,, | one-twenty-seventh. |
| In S.W. Australia | ,, | less than one-fourth | ,, | ,, | one-hundredth. |
| In Tasmania | ,, | one-third | ,, | ,, | one-fifteenth. |

* These and the following numbers will not be found to accord exactly with the data on the preceding pages, because, since the earlier sheets of the latter were printed off, I have received collections and notes from Archer, Gunn, and Mueller, that slightly alter the number of the species, varieties, and their distribution. *Stackhousia pulvinaris*, Muell. (see Vol. II. Suppl.), should be added at p. lx.; "Australia" should be added to the distribution of *Eryngium vesiculosum* (p. lxv.) and to *Calocephalus lacteus* and the ten following species (p. lxvii.). "Isle of Pines" should be expunged from 587.

There is thus a very remarkable rise in the proportion of European forms in Tasmania, and this is not due to the extension of all the European plants of Australia into Tasmania, for there are in the latter island several European genera and species that have not been found on the continent; as—

| | | |
|---|---|---|
| Ranunculus aquatilis. | Draba nemoralis. | Montia fontana. |
| Anemone. | Hierochloe borealis. | Trisetum subspicatum. |
| Thlaspi ? | | |

On the other hand, the Victoria Alps contain several northern European forms which have not been found in Tasmania, as—

| | | |
|---|---|---|
| Turritis glabra. | Lysimachia vulgaris. | Carex Buxbaumii. |
| Sagina procumbens. | Alisma Plantago. | Carex vulgaris (*fid. Muell.*) |
| Myriophyllum verticillatum. | Actinocarpus. | Carex canescens ditto. |
| Alchemilla vulgaris. | Hydrilla dentata. | Carex echinata ditto. |
| Samolus Valerandi. | Carex stellulata. | Carex Pyrenaica. |

The New Zealand Flora is another which enters proportionately much more largely into the Tasmanian than into the Australian, nearly 200 of the genera and 170 of the species of Tasmania being common to New Zealand; and these countries further contain various representative genera and species, which will be found in the Introductory Essay to the 'New Zealand Flora,' and in the section of this Essay devoted to a comparison of the New Zealand and Australian Floras.

From the higher latitude of Tasmania, and its loftier mountains, it contains further a larger proportion of antarctic plants, nearly 100 genera and 56 species being common to this island and the groups south of New Zealand, Fuegia, the Falkland Islands, etc.

A strict comparison of the continental Australian and Tasmanian Floras cannot be fully carried out, until much larger suites of specimens from both countries have been selected and compared. It is evident that many of the plants that rank as peculiar to Tasmania, are slightly though permanently altered forms, no less than 100 of the 1063 being so considered, with more or less certainty or plausibility, by Mueller or Archer or myself, and some by all of us. To enter into a discussion of them here would be quite useless.

Another interesting subject of detail, requiring fuller materials, is the alpine Flora of Tasmania, upon which Mueller's Victorian Alps collections have thrown so much light. I find, on a rough estimate, that there are 200 alpine and subalpine species in Tasmania (of which half are alpine); considering as such those which are most prevalent in or confined to altitudes above 3,000 feet: of these 30 are probably altered forms of lowland plants; 120 are of Australian genera (10 of them are probably varieties); about 10 are of New Zealand genera; 55 are of European genera (17 of them probably varieties); and 25 are Antarctic forms.

This proportion of varieties amongst the alpine and subalpine plants, amounting as it does to 15 per cent., is very large; the proportion amongst the lowland plants being considerably under 10 per cent. The small proportion of varieties amongst the alpines belonging to Australian genera compared with those of European genera is also worthy of notice, as an exemplification of an observation made by Mr. Darwin, that the species of widely distributed genera are more variable than those of local genera.

The locality indicated by the letters "Ch." as the habitat of many Tasmanian plants collected by Mr. Archer, consists of a tract of country (in which is included his estate of Cheshunt, about ten miles south-west of Deloraine and 600 feet above the sea), extending southerly from Mount Gog, on the Mersey, to the Falls of the Meander, and westerly from Quamby's Bluff to the Lobster Rivulet; the whole comprising an area of about 400 square miles.

The rocks of the northern part of this tract, including Mount Gog, are chiefly quartzite; and the remainder, including a portion of the Western Mountains, elevated fully 4,000 feet, are for the most part basalt. Immediately above Cheshunt, to the south-west, rises an offset of the western mountains, named Cumming's Head, along the north-east base of which extends a tract of sandstone and fossiliferous limestone, which is the habitat of nearly all Mr. Archer's cryptogams.

This district has already produced nearly 550 flowering plants, or rather more than half of all that are known to inhabit Tasmania. The character of the Cheshunt Flora is, on the whole, that of a cold hilly region, approaching, in many respects, to the subalpine, and is hence even less Australian than that of all Tasmania is. The absence of all but four *Rhamneæ*, the paucity of *Restiaceæ*, *Myrtaceæ*, *Liliaceæ*, and *Leguminosæ*, the abundance of *Orchideæ*, *Compositæ*, and *Epacrideæ*, are amongst the most noticeable features.

## § 9.

### *On the New Zealand and Polynesian features of the Australian Vegetation.*

I have already remarked that these features, in so far as they are peculiar, are confined to the east and south-east coasts of Australia, and chiefly to the temperate regions, including Tasmania. There is a great difference between the temperate and tropical Floras of eastern Australia in respect to the character of their non-endemic genera and species, for the former appears to have received immigrants from New Zealand and the Antarctic regions, whilst the latter contains an assemblage of forms common to itself, India, and the Pacific. There is, however, no evidence in either case that the migration has been in one direction more than in another: Tasmania may once have been peopled by New Zealand and antarctic forms, before the Australian vegetation spread over it and replaced these; and Australia itself may have derived its peculiar features from some Pacific islands which have since been overrun by an Indian vegetation. I have therefore not subdivided this Section, but shall regard the affinities, both tropical and temperate, under the same point of view.

To the eastward of Australia are various groups of islands so arranged as to form a sort of rude outlying girdle to that continent. Beginning from the northward, these are the Solomon's Islands, New Hebrides, New Caledonia, Norfolk Island, and the New Zealand group; to which might be added Eastern New Guinea, the Louisiade Archipelago, and New Ireland, but I know very little of their botany.

The common botanical feature of all of these archipelagos, that lie to the north and east of the New Hebrides, and indeed of all the Polynesian groups westward of Juan Fernandez and the Galapagos (which are wholly American), is that they are peopled mainly by Indian and Australian genera, and in a very slight degree by American; but these Floras (Indian, Australian, and American) are represented in very different proportions in different groups; and I have observed (note at p. xvi.), that there are in this respect considerable anomalies in the Floras of contiguous archipelagos, those immediately to the eastward of New Caledonia* being remarkably deficient in Australian genera.

* In the only published volume of Asa Gray's 'Botany of Wilkes's Exploring Expedition,' I have found the Fiji, Navigators', Friendly, and Society Islands to be represented by upwards of 140 genera of *Thalamifloræ* and *Calycifloræ* (208 species). Only 26 genera are not Indian, and almost all of them are either new or confined to these groups; nor do I find one characteristic Australian plant amongst them, except a phyllodineous *Acacia*.

Commencing with the New Hebrides and New Caledonia, I find, that out of a list of scarcely 100 species known to me, there are no less than 12 markedly Australian generic types, viz. *Disemma, Eriostemon, Kennedya,* phyllodineous *Acaciæ, Leptospermum, Bæckia, Metrosideros, Didiscus, Coprosma, Cassinia, Leucopogon, Dracophyllum, Lomatia, Stenocarpus, Grevillea, Exocarpus, Casuarina, Araucaria, Microtis, Lyperanthus, Geitonoplesium, Stypandra, Lamprocarya.*

Norfolk Island, which lies intermediate between the New Hebrides and New Zealand, presents a Flora of intermediate character. Besides containing many New Zealand plants not hitherto found in the New Hebrides, it contains the following Australian types not found in New Zealand:—*Jasminum gracile, Excæcaria Agallocha, Myrsine crassifolia, Pimelea linifolia, Achyranthes canescens, Araucaria, Geitonoplesium cymosum.*

New Zealand presents a long list of Australian genera, including many that are very characteristic of that continent, but wholly wants some of the most extensive and widely distributed (both in area and elevation) of these, as *Eucalyptus, Acacia, Stylidium, Casuarina, Callitris, Xyris, Xerotes, Thysanotus, Hibbertia, Pleurandra, Banksia, Dryandra, Grevillea, Hakea.*

At p. xxxvii. I have enumerated the 23 largest Australian genera, all containing from 50 to upwards of 200 species; of these no less than 15 have no New Zealand representative, and all but 2 have very few indeed. In other words, of the 23 Australian genera which number upwards of 50 species each, and which together include about 2,000 species, only 8 are found in New Zealand, and of these, *Drosera, Dodonæa, Helichrysum,* and *Leucopogon,* are all widely distributed elsewhere; of the 7 Australian genera, with upwards of 100 species each, only *Leucopogon* is a New Zealand one.

It is even more remarkable that most of the highly characteristic Australian Orders are wholly or nearly absent in New Zealand: thus, instead of 100 genera and 1,000 species of *Leguminosæ* there are but 4 genera, all but one different (*Clianthus*), and 8 species, all different. Of *Myrtaceæ,* with 60 Australian genera and 600 species, there are but 4 genera and 15 species in New Zealand. The 5 Australian genera (including 100 species) of *Dilleniaceæ* have no representative, nor has the Order; and of *Stylidieæ,* in lieu of 5 genera and 115 species, there is but one genus, and that antarctic. Of *Goodeniaceæ,* which in Australia has 20 genera and 230 species, there is but one species in New Zealand, and that a salt-marsh plant also common to Chili and Tasmania. Lastly, there are no representatives whatever of—

| | | | |
|---|---|---|---|
| Capparideæ. | Frankeniaceæ. | Buettneriaceæ. | Xyrideæ. |
| Polygaleæ. | Tremandreæ. | Casuarineæ. | Hæmodoraceæ. |

and very few of—

| | | | |
|---|---|---|---|
| Stackhousieæ. | Santalaceæ. | Verbenaceæ. | Loganiaceæ. |
| Myoporineæ. | Irideæ. | Rhamneæ. | |

To put this is in another point of view, I will give a comparative table of the relative magnitude of the 9 largest Natural Orders in each country, which Orders include upwards of half the species in each, and from which it will be seen that only 5 of the New Zealand Orders appear in the other lists.

| *New Zealand.* | *Australia.* | *Tasmania.* |
|---|---|---|
| 1. Compositæ. | Leguminosæ. | Compositæ. |
| 2. Cyperaceæ. | Myrtaceæ. | Orchideæ. |
| 3. Gramineæ. | Proteaceæ. | Epacrideæ. |
| 4. Scrophularineæ. | Compositæ. | Leguminosæ. |

| *New Zealand.* | *Australia.* | *Tasmania.* |
|---|---|---|
| 5. Orchideæ. | Gramineæ. | Cyperaceæ. |
| 6. Rubiaceæ. | Cyperaceæ. | Gramineæ. |
| 7. Epacrideæ. | Epacrideæ. | Myrtaceæ. |
| 8. Umbelliferæ. | Goodeniaceæ. | Liliaceæ. |
| 9. Ranunculaceæ. | Orchideæ. | Proteaceæ. |

Another remarkable difference between these Floras is afforded by certain American genera being found in each, but which are not common to both. Of these the most striking are—

| | *New Zealand.* | | *Australia and Tasmania.* | |
|---|---|---|---|---|
| Drimys. | Fuchsia. | Callixene. | Eucryphia. | Styloncerus. |
| Coriaria. | Calceolaria. | Gaimardia. | Œnothera. | Pernettya. |
| Edwardsia. | Thuja. | Rostkovia. | Flaveria. | Prionotes. |

So too with regard to the European genera and species, there are certain temperate and northern species found in New Zealand but not in Australia, such as—

Taraxacum officinale, Veronica Anagallis, Sparganium natans, Agrostis canina.

Turning now to the points of affinity betwen Australia and New Zealand, these are so numerous and decided as to render the dissimilarities all the more singular.

In the first place, there is no New Zealand Order absent from Australia except *Coriarieæ, Brexiaceæ,* and *Chloranthaceæ,* which are single genera rather than Orders. Of the 282 genera of Phænogams in New Zealand, 240 are also Australian, and 60 are almost confined to these two countries. The greatest amount of generic affinity exists in three of the largest Orders in each, viz. *Compositæ, Orchideæ,* and *Gramineæ,* which may be considered generically identical in both. To this category of resemblances also belong the antarctic genera and representative genera, many of which are also found in America, and which will be hereafter considered. Of these 240 genera, by far the larger proportion are confined to eastern Australia, not one being exclusively western Australian.

Descending to species, I find that 216, or one-fourth of the New Zealand Phænogams, are natives of Australia,* and of these 115 are confined to these two countries. Of the remaining 101, 77 are common to America, 75 to India, and 52 to Europe. The comparatively small number of these that are common to India, and greater number common to America, is a remarkable fact, considering the relative position of these countries; and the large number of European genera is no less so.

Another interesting anomaly is, that of the 115 species peculiar to Australia and New Zealand, only 26 belong to genera peculiar to those countries, and only 6 to the long list of Australian genera that contain upwards of 20 species each. Again, upwards of 20 of these 115 are scarce and chiefly alpine plants in both countries, occupying comparatively very small areas; whereas of the 101 that are found in other lands besides Australia and New Zealand, only 5 or 6 are alpine, and most of these are antarctic also.

Thus, under whatever aspect I regard the Flora of Australia and New Zealand, I find all attempts to theorize on the possible causes of their community of feature frustrated by anomalies in distribution such as I believe no two other similarly situated countries in the globe present. Everywhere else I recognize a parallelism or harmony in the main common features of contiguous Floras, which

* The majority of these will be found in the Tasmanian Classified List at p. lvi., with the indication of their being natives of New Zealand.

conveys the impression of their generic affinity at least being effected by migration from centres of dispersion in one of them, or in some adjacent country. In this case it is widely different. Regarding the question from the Australian point of view, it is impossible in the present state of science to reconcile the fact of *Acacia,* *Eucalyptus*, *Casuarina*, *Callitris*, etc., being absent in New Zealand, with any theory of transoceanic migration that may be adopted to explain the presence of other Australian plants in New Zealand; and it is very difficult to conceive of a time or of conditions that could explain these anomalies, except by going back to epochs when the prevalent botanical as well as geographical features of each were widely different from what they are now. On the other hand, if I regard the question from the New Zealand point of view, I find such broad features of resemblance, and so many connecting links that afford irresistible evidence of a close botanical connection, that I cannot abandon the conviction that these great differences will present the least difficulties to whatever theory may explain the whole case. I shall again allude to this point after discussing the antarctic and European features of Australia.

Between Norfolk Island and Australia a few small islands rise like specks in the ocean, and these, too, tell a tale of distribution. Lord Howe's Island and the Middleton group, in the parallels of 28° and 32° south, have both been botanized in by the officers of the 'Herald' (Captain Denham's Pacific Exploring Expedition), and their Flora is of an intermediate character between that of Australia, New Zealand, and Norfolk Island, some species being common to each, and the rest, though quite distinct, being closely allied to the plants of these countries.

## § 10.

### *On the Antarctic Plants of Australia.*

From the geographical position of Australia, no less than from the altitude of its southern mountains, it is well placed for the maintenance of those types of vegetation which I have denominated Antarctic. These, it must be remembered, are not so called because they really inhabit the country of that name beyond the Polar circle, but because in a botanical point of view, no less than in position relative to the south temperate Flora, they represent the Arctic Flora. They might indeed almost be called alpine plants, for many which are found at the level of the sea in the so-called Antarctic islands, also ascend the mountains of more genial latitudes. An alpine vegetation, however, in the tropics especially, is supposed to commence only where the forest is replaced by low brushwood; whereas, owing to the uniformity and humidity of the high southern latitudes, an arboreous vegetation there encroaches upon the limits of perpetual ice. In the longitude of Cape Horn, on the mountains of Fuegia, of the Middle Island of New Zealand, and of Australia, the belt of country occupied by low and chiefly herbaceous plants, that intervenes between the arboreous vegetation and the extinction of phænogamic life, is a very narrow one indeed compared with what analogous regions the Alps, Andes, Himalaya, or Arctic latitudes present.

In discussing the antarctic vegetation of Australia, I shall have to adopt a style that appears to indicate that this Flora is an immigrant, whereas it may, to a considerable extent, both in Australia and elsewhere, consist of altered forms of the plants of that continent, which have migrated from

* There are no climatic or other reasons against these genera flourishing in New Zealand when introduced there. Some introduced Australian plants have already become naturalized in New Zealand; but upon this point I hope to collect more full evidence.

it to the Antarctic regions; just as the endemic alpine Floras of Tasmania and Victoria are to an appreciable degree composed of altered lowland species, or *vice versâ*. Taking for example such an eminently antarctic genus as *Acæna*,† which is not known in the northern hemisphere, except in America and the Sandwich Islands (but which is elsewhere in that hemisphere represented by *Poterium* and *Sanguisorba*), its distribution is very wide and disconnected, yet it is so universally present in all high southern lands, both under the forms of temperate, alpine, and antarctic species, that it is impossible to regard it under any other category than the vague one of antarctic.

Premising that the so-called antarctic vegetation is that of the islands south of New Zealand, West Chili south of Cape Tresmontes, Fuegia, the Falklands and other islands south of them, Tristan d'Acunha, and Kerguelen's Land, I shall proceed to indicate which of the plants of these countries are actually present, or are represented by allied genera or species in Australia.—E prefixed distinguishes the European species.

| | Australia and Tasmania. | Islands south of New Zealand. | Fuegia, etc., Tristan d'Acunha, and Kerguelen's Land. |
|---|---|---|---|
| | Caltha introloba, *Muell.* | C. Novæ-Zelandiæ, *H.f.* | C. sagittata, *Cav.* |
| | Tasmania aromatica, *Br.* | D. *axillaris, *Forst.* | Drimys Winteri, *Forst.* |
| E | Cardamine hirsuta, *L.* | C. hirsuta, *L.* | C. hirsuta, *L.* |
| | Drosera Arcturi, *Hook.* | D. Arcturi, *Hook.* | D. uniflora, *Willd.* |
| E | Stellaria media, *Sm.* | S. media, *Sm.* | S. media, *Sm.* |
| E | Sagina procumbens, *L.* | | S. procumbens, *L.* |
| | Colobanthus Billardieri, *Fenzl.* | C. Billardieri, *Fenzl.* | C. crassifolius, *H.f.* |
| | Colobanthus subulatus, *H.f.* | C. subulatus, *H.f.* | C. subulatus, *H.f.* |
| E | Geranium dissectum, *L.* | | G. dissectum, *L.* |
| | Geranium potentilloides, *L'Hérit.* | G. potentilloides, *L'Hérit.* | G. Patagonicum, *H.f.* |
| | Pelargonium Acugnaticum, *Pet. Th.* | P. *Acugnaticum, *Pet. Th.* | P. *Acugnaticum, *Pet. Th.* |
| | Oxalis Magellanica, *Forst.* | O. Magellanica, *Forst.* | O. Magellanica, *Forst.* |
| E | Potentilla anserina, *L.* | P. anserina, *L.* | P. anserina, *L.* |
| E | Geum urbanum, *L.* | G. *urbanum, *L.* | G. urbanum, *L.* |
| | Acæna Sanguisorba, *Vahl.* | A. Sanguisorba, *Vahl.* | A. lævigata, *Ait.* |
| E | Epilobium tetragonum, *L.* | E. *tetragonum, *L.* | E. tetragonum, *L.* |
| | Myriophyllum elatinoides, *Gaud.* | M. *elatinoides, *Gaud.* | M. elatinoides, *Gaud.* |
| | Gunnera cordifolia, *H.f.* | G. *monoica, *Bl.* | G. Magellanica, *Lam.* |
| E | Callitriche verna, *L.* | C. verna, *L.* | C. verna, *L.* |
| E | Montia fontana, *L.* | M. fontana, *L.* | M. fontana, *L.* |
| | Crantzia lineata, *Nutt.* | C. *lineata, *Nutt.* | C. lineata, *Nutt.* |
| | Apium australe, *Pet. Th.* | A. *australe, *Pet. Th.* | A. australe, *Pet. Th.* |
| | Oreomyrrhis Colensoi, *H.f.* | O. *Colensoi, *H.f.* | O. andicola, *Endl.* |
| | Coprosma pumila, *H.f.* | C. pumila, *H.f.* | |
| | Nertera depressa, *B. & S.* | N. depressa, *B. & S.* | N. depressa, *B. & S.* |
| | Trineuron scapigerum, *Muell.* | T. spathulatum, *H.f.* | |
| | Scleroleima forsteroides, *H.f.* | | Abrotanella emarginata, *Cass.* |

† One species (*A. pinnatifida*, R. & P.), is found both in Chili and in California, but not in any intermediate latitude. California, Mexico, and the Sandwich Islands are almost the only habitats of the genus in the northern hemisphere.

* An asterisk indicates those species which, being common to Tasmania and Fuegia, etc., are found on the mountains of New Zealand, though not in the islands south of it.

| Australia and Tasmania. | Islands south of New Zealand. | Fuegia, etc., Tristan d'Acunha, and Kerguelen's Land. |
|---|---|---|
| Leptinella intricata, *H.f.* | L. plumosa, *H.f.* | L. scariosa, *Cass.* |
| Erechtites prenanthoides, *DC.* | E. prenanthoides, *DC.* | |
| Forstera bellidifolia, *Hook.* | F. clavigera, *H.f.* | F. muscifolia, *Willd.* |
| Selliera radicans, *Cav.* | S. *radicans, *Cav.* | S. radicans, *Cav.* |
| Pernettya Tasmanica, *H.f.* | | P. pumila, *Hook.* |
| Prionotes cerinthoides, *Lab.* | | P. Americana, *Hook.* |
| Gentiana montana, *Forst.* | G. montana, *Forst.* | G. Magellanica, *Gaud.* |
| E Calystegia sepium, *Br.* | C. *sepium, *Br.* | C. sepium, *Br.* |
| E Limosella aquatica, *L.* | L. *aquatica, *L.* | L. aquatica, *L.* |
| Ourisia integrifolia, *Br.* | O. *macrophylla, *Hook.* | O. Magellanica, *Juss.* |
| Samolus littoralis, *Br.* | S. *littoralis, *Br.* | S. littoralis, *Br.* |
| Plantago Brownii, *Rap.* | P. Brownii, *Rap.* | P. barbata, *Forst.* |
| E Chenopodium glaucum, *L.* | C. *glaucum, *L.* | C. glaucum, *L.* |
| Lomatia tinctoria, *Br.* | | L. ferruginea, *Br.* |
| Drapetes Tasmanica, *H.f.* | D. Lyallii, *H.f.* | D. muscosa, *Lamk.* |
| Fagus Gunnii, *H.f.* | | F. Antarctica, *Forst.* |
| Fagus Cunninghamii, *Hook.* | F. Menziesii, *H.f.* | F. betuloides, *Mirb.* |
| Astelia alpina, *Br.* | A. linearis, *H.f.* | A. pumila, *Br.* |
| Triglochin triandrum, *Mirb.* | T. *triandrum, *Mirb.* | T. triandrum, *Mirb.* |
| Juncus planifolius, *Br.* | J. *planifolius, *Br.* | J. planifolius, *Br.* |
| Oreobolus Pumilio, *Br.* | O. Pumilio, *Br.* | O. obtusangulus, *Gaud.* |
| Carpha alpina, *Br.* | C. *alpina, *Br.* | C. schœnoides, *B. & S.* |
| E Isolepis pygmæa, *Kth.* | I. *pygmæa, *Kth.* | I. pygmæa, *Kth.* |
| Carex appressa, *Br.* | C. appressa, *Br.* | |
| Hierochloe redolens, *Br.* | H. redolens, *Br.* | H. redolens, *Br.* |
| E Deschampsia cæspitosa, *Pal.* | D. cæspitosa, *Pal.* | D. cæspitosa, *Pal.* |
| E Trisetum subspicatum, *Pal.* | T. subspicatum, *Pal.* | T. subspicatum, *Pal.* |
| E Festuca duriuscula, *L.* | F. *duriuscula, *L.* | F. duriuscula, *L.* |
| Festuca littoralis, *Lab.* | F. littoralis, *Lab.* | |

The most curious point in this list is the number of European species it contains, amounting to seventeen, of which most are British; there are besides two other species which inhabit the north temperate zone of the New World, *Triglochin triandrum* and *Crantzia lineata; Apium australe* is in some of its states with difficulty distinguished from *A. graveolens*.

The genera that are most characteristic of the Antarctic regions amongst them are,—*Colobanthus, Acæna, Donatia, Nertera, Forstera, Leptinella, Ourisia, Drapetes, Fagus, Oreobolus,* and *Carpha*. Only one (*Lomatia*) can be said to betray any generic affinity between the peculiar Flora of Australia and the Antarctic regions; though *Forstera,* as belonging to *Stylidieæ,* may be classed with Australian representatives.

## § 11.

### *On the South African features of Australian Vegetation.*

The relations between the Floras of Australia and of the same latitudes in Africa, are of a very different character from those that exist between it and Polynesia, or India, etc., or even Europe; for whereas there is a very definable affinity traceable in the presence and abundance of some peculiar Orders, there is very little generic affinity in those Orders, and scarcely any specific identity.

My data for the African Flora are chiefly derived from my friend Dr. Harvey's communications, his 'Genera of South African Plants,' Drége and Meyer's 'Zwei Pflanzen-geographische Documente' (Flora, 1843), the Niger Flora, and the Natal, West African, and Mauritius plants in the Herbarium at Kew.

With regard to the tropical Floras of Australia and Africa, their agreement is in rather less than 300 genera, and in about 200 species that are without exception common to India also, and hardly any of which belong to those genera or natural families* that are characteristic of the South African or Australian Flora. This subject therefore requires no further illustration than it has received under the Indian chapter.

With regard to the temperate South African Flora, it is perhaps as widely different from the tropical as the temperate Australian is from that of the Malayan Islands; and an extraordinary number of species, many of them belonging to a few genera and orders elsewhere rare, are massed towards the south extreme of Africa, and there confined to a tract of land of varying width, interposed between the sea and a desert interior.

The most conspicuous characters that extratropical South Africa presents in common with Australia, are the abundance of species of the following Orders, many of which being shrubby, give in certain districts of each country a character to the landscape.

| | | |
|---|---|---|
| Proteaceæ. | Polygaleæ. | Rutaceæ. |
| Compositæ. | Restiaceæ. | Thymeleæ. |
| Irideæ. | Epacrideæ, Ericeæ. | Santalaceæ. |
| Hæmodoraceæ. | Decandrous Papilionaceæ and tribes Podalyrieæ and Loteæ. | Anthospermous Rubiaceæ. |
| Buettneriaceæ. | | |

All these Orders are far more abundantly represented in Australia (especially south-western) and South Africa than in any other part of the world, added to which by far the greater number of the known genera and species of *Proteaceæ* and *Restiaceæ* are confined to these two countries. Other marks of affinity are the *Cycadeæ*, the genus *Encephalartos* (to which Mueller reduces *Macrozamia*) being common to both; *Cyphiaceæ* (according to Brown a suborder of *Goodeniaceæ*) are almost confined to South Africa. Numerous terrestrial *Orchideæ, Droseraceæ, Zygophylleæ, Liliaceæ, Smilaceæ,* and *Capparideæ;* the genera *Pelargonium* and *Mesembryanthemum*, besides *Metrosideros, Acæna, Tetragonia, Weinmannia, Sarcostemma, Sebæa, Callitris,*† *Anguillaria, Restio, Carpha, Uncinia,* and *Ehrharta.*

* As exceptions may rank the few *Proteaceæ* said to exist in Abyssinia, which however belong to genera widely different from the Australian. The late Professor A. Richard gave me to understand (Preface to 'Flora Antarctica,' vol. ii. p. 210) that there were many representatives of the South African peculiarities in Abyssinia, but I find they are not so numerous as I was led to suppose.

† I include *Frenela* and *Widdringtonia* under *Callitris*, one species of which is found in North Africa.

The rarity in both of *Aroideæ, Laurineæ,* and all *Rubiaceæ* except the *Anthospermeæ,* is also worthy of notice. With regard to the Natural Orders enumerated above, their genera are almost unexceptionally different in the two countries. I find that of 1,000 South African genera of flowering plants, only about 280 are Australian; of these about 160 are also common to Europe, and 130 to India, leaving *Callitris, Encephalartos, Restio, Hypolæna,* and *Anguillaria,* confined to South Africa and Australia, and 10 more common to these countries, together with New Zealand and extratropical America.

On the other hand, South Africa contains upwards of 220 European genera, of which 80 are not Australian, and of these upwards of 60 are north temperate forms. We have hence the very curious fact that in point of numbers Australia represents generically the European Flora better than South Africa does; but that the South African Flora contains a larger proportion of very northern European genera (not species) than Australia does. This is no doubt because many of the so-called European genera of Australia are more properly Asiatic, and spread thence in both directions, towards Europe and towards Australia.

Before dismissing this subject, it is as well to glance at the differences between these Floras, which may shortly be summed up. South Africa abounds in *Campanulaceæ,* which are very rare in Australia, where the very closely allied Orders *Stylidieæ* and *Goodeniaceæ* abound. The true *Ericeæ,* which swarm in certain districts of South Africa, are all but wholly absent in Australia, being represented there by their suborder *Epacrideæ.* Succulents are, comparatively, extremely rare in Australia, which almost wholly wants those conspicuous features of South African vegetation the *Crassulaceæ, Ficoideæ,* fleshy *Asclepiadeæ, Liliaceæ* (Aloes), and *Euphorbieæ.*

I have given (p. xxxiii.) a list of the five Orders which abound more in South Africa than in any other country but Australia, and are therefore highly characteristic of both these. I shall now give the contrasting ordinal dissimilarities of each.

The following Orders are represented in the South African Flora, but are either comparatively rare or absent in Australia :—

Fumariaceæ, absent in Australia.
Resedaceæ, ditto.
Bixaceæ.
Tamariscineæ, ditto.
Geraniaceæ.
Oxalideæ.
Caryophylleæ.
Ficoideæ.
Rosaceæ.
Bruniaceæ, ditto.
Loaseæ, ditto.
Penæaceæ, ditto.
Begoniaceæ, ditto.
Crassulaceæ.
Valerianeæ, ditto.
Dipsaceæ, absent in Australia.
Arctotideæ (tribe of *Comp.*).
Ericeæ.
Campanulaceæ.
Stilbineæ (*Verben.*), absent in Australia.
Selagineæ (*Verben.*), ditto.
Asclepiadeæ.
Podostemaceæ, ditto.
Saurureæ, ditto.
Rafflesiaceæ, absent in Australia.
Cytineæ, ditto.
Betulaceæ, ditto.
Salicineæ, absent in Australia.
Hypoxideæ.

Temperate Australia contains the following Orders that are rare or absent in South Africa :—

Dilleniaceæ, absent in South Africa.
Magnoliaceæ, ditto.
Monimiaceæ. ditto.
Sapindaceæ.
Tremandreæ, absent in South Africa.
Pittosporeæ.
Stackhousieæ, ditto.
Halorageæ.

| | | | |
|---|---|---|---|
| Myrtaceæ. | | Labiatæ. | |
| Caprifoliaceæ, absent in South Africa. | | Lentibularineæ. | |
| Goodeniaceæ, | ditto. | Plantagineæ, absent in South Africa. | |
| Stylidieæ, | ditto. | Cupuliferæ, | ditto. |
| Brunoniaceæ, | ditto. | Casuarineæ, | ditto. |
| Epacrideæ, | ditto. | Coniferæ. | |
| Loganiaceæ. | | Xerotideæ, | ditto. |
| Myoporineæ, | ditto. | Phylidreæ, | ditto. |

It is singular that there should be exactly the same number (sixteen) of Orders absent in each country; of these, however, three Australian ones are confined to the south-eastern part of that continent, *Magnoliaceæ, Monimiaceæ,* and *Caprifoliaceæ,* which is in accordance with the facts I have elsewhere indicated, that the affinity between the Floras of South-west Australia and South Africa is very markedly greater than between that country and South-east Australia.

I shall return to the consideration of the European genera of South Africa in the following section of this Essay.

## § 11.

### *On the European Features of the Australian Flora.*

In one respect this is by far the most difficult subject to treat of to the satisfaction of many persons interested in the study of the distribution of plants; for situated as Australia is, at the antipodes of Europe, the presence in it of many forms common to both, whether generic or specific, affords so strong an argument in favour of there being many centres of creation for each vegetable form, that I cannot expect the believers in that doctrine to follow me far. I have given my own reasons for dissenting from that view and inclining to the opposite one, that variation will account for change of species and genera; that the force of variation being a centrifugal one tends to diversity of forms and opposes reversion; that Darwin's theory of natural selection accounts for the temporary stability of many forms we call species; that the destruction of species by natural causes resolves species into genera, etc.; and that if we allow time enough, these several operations may have worked together and produced, out of what would otherwise be to us a homogeneous series of vegetable forms, a series broken up into varieties, species, and genera, all of unequal value, and of multiplied cross-affinities. I now pursue the subject of the European affinities of the Australian Flora in subjection to these views, not because I insist that they are right, nor because I expect to explain the facts by them, but because I conceive these hypotheses to be, in the present state of science, as legitimately tenable as those of absolute creations and multiplied centres, and far more suggestive to future inquirers of fresh ideas, that may be worked into one class of hypotheses or the other.

The following is a list of the European genera and species hitherto discovered in Australia. I have indicated by *As.* those which, though found in Europe, are so scarce there, and so much more characteristic of Asia, that they cannot be considered as direct instances of affinity between Australia and Europe; and by *Trop.* those genera that are only found in tropical or subtropical Australia. Those marked with an asterisk are possibly introduced.

Ranunculus *aquatilis.*
—— *parviflorus.*
Anemone.
Clematis.
Myosurus.
Caltha.
As. Nelumbium *speciosum.* Tr.
As. Nymphæa *Lotus.* Trop.
Papaver.
Lepidium **ruderale.*
Draba *nemoralis.*
Cardamine *hirsuta.*
—— *pratensis.*
Arabis.
Barbarea *vulgaris.*
Nasturtium *terrestre.*
Senebiera. Trop.
Erysimum.
Hutchinsia *procumbens.*
Sisymbrium *thalianum.*
Turritis *glabra.*
Thlaspi ?
As. Capparis *spinosa.*
Cleome.
Viola.
Drosera.
Polygala.
Frankenia.
*Gypsophila *tubulosa.*
Spergularia *rubra.*
Scleranthus.
Stellaria *media.*
—— *glauca.*
Sagina *procumbens.*
Linum.
Elatine.
Lavatera.
As. Malva. Trop.
As. Sida. Trop.
As. Hibiscus *Trionum.*
As. Vitis. Trop.
Geranium *dissectum.*
Oxalis *corniculata.*
Hypericum.
Zygophyllum.

As. Tribulus. Trop.
As. Celastrus. Trop.
As. Zizyphus. Trop.
As. Phaseolus. Trop.
Lotus *corniculatus.*
Trigonella.
As. Cassia. Trop.
As. Sophora. Trop.
As. Psoralea. Trop.
Geum *urbanum.*
Potentilla *anserina.*
Rubus.
Alchemilla *arvensis.*
—— *vulgaris.*
Callitriche *verna.*
—— *platycarpa ?*
Ceratophyllum *demersum.*
As. Ludwigia. Trop.
As. Ammannia. Trop.
Epilobium *tetragonum.*
Lythrum *Salicaria.*
—— **hyssopifolium.*
As. Myrtus. Trop.
Montia *fontana.*
Mesembryanthemum.
As. Glinus *lotoides.*
As. Portulaca *oleracea.*
Tillæa.
Hydrocotyle *vulgaris.**
Helosciadium ?
Sium *latifolium.*
Eryngium.
Apium.
Daucus.
Seseli.
As. Loranthus. Trop.
As. Viscum. Trop.
Sambucus.
Asperula.
Galium.
Erigeron.
Conyza *ambigua.*
Bidens *cernua.*
—— *pilosa.*
Cotula *coronopifolia.*

As. Myriogyne *minuta.*
Antennaria.
Helichrysum.
Gnaphalium *luteo-album.*
Senecio.
Sonchus *asper.*
Picris *hieracioides.*
Lobelia.
Wahlenbergia.
As. Olea. Trop.
As. Jasminum.
As. Diospyros. Trop.
Gentiana.
Villarsia.
Erythræa.
As. Cynanchum. Trop.
Cuscuta.
As. Cressa *Cretica.*
As. Convolvulus *althæoides ?*
Calystegia *sepium.*
—— *Soldanella.*
As. Ipomœa. Trop.
Solanum *nigrum.*
As. Physalis. Trop.
As. Lycium.
As. Heliotropium. Trop.
Myosotis.
Cynoglossum.
As. Echinospermum. Trop.
Eritrichium.
As. Tournefortia, Trop.
Euphrasia.
Veronica *serpyllifolia.*
Limosella *aquatica.*
As. Gratiola.
Verbena *officinalis.*
As. Lippia *nodiflora.* Trop.
As. Vitex. Trop.
Mentha.
Lycopus *Europæus.*
Prunella *vulgaris.*
Scutellaria.
Teucrium.
Ajuga.
Utricularia.

* Introduced on the authority of Brown's list in the Appendix to Flinders's Voyage.

Lysimachia *vulgaris*.
Samolus *Valerandi*.
As. Plumbago. Trop.
Statice.
Plantago.
As. Boerhaavia. Trop.
Polygonum *minus*.
—— *aviculare*.
—— *mite*.
—— *lapathifolium*.
Rumex.
Chenopodium *glaucum*.
—— *murale*.
Blitum *virgatum*
Atriplex **rosea*.
Kochia.
Suæda *maritima*.
Echinopsilon.
Halocnemon.
Arthrocnemon *Arbuscula*.
Salsola *Kali*.
Euxolus *viridis*.
As. Alternanthera *nodiflora*.
As. Achyranthes. Trop.
Thesium.
As. Euphorbia *Chamæsyce*. Tr.
As. Croton. Trop.
Urtica.
Parietaria *debilis*.
As. Ficus. Trop.
Fagus.
As. Ephedra. Trop.
Vallisneria *spiralis*.
As. Hydrilla *dentata*.
As. Habenaria. Trop.
Spiranthes.
Alisma *Plantago*.
Actinocarpus *Damasonum?*
Triglochin.
Zannichellia *palustris ?*
Naias *major ?*
Ruppia *maritima*.
Zostera *marina*.
Posidonia.
Potamogeton *natans*.
Potamogeton *crispus*.
Potamogeton *prælongus ?*
—— *perfoliatus*.
—— *pectinatus*.
—— *obtusifolius ?*
Lemna *minor*.
—— *trisulca*.
Sparganium *ramosum*.
Typha *angustifolia*.
As. Asparagus. Trop.
Smilax.
Juncus *bufonius*.
—— *communis*.
—— *maritimus*.
Luzula *campestris*.
As. Eriocaulon.
As. Fuirena. Trop.
As. Fimbristylis, Trop.
Cyperus *rotundus*.
—— *mucronatus*.
—— *pygmæus*.
—— *difformis*.
Elæocharis *palustris*.
—— *acicularis*.
Scirpus *mucronatus*.
—— *triqueter*.
—— *maritimus*.
—— *Rothii*.
—— *lacustris*.
Malacochæte *pectinata*.
Isolepis *setacea*.
—— *supina*.
—— *Saviana*.
—— *fluitans*.
Scirpus *lacustris*.
—— *maritima*.
—— *triqueter*.
As. Rhynchospora.
Cladium *Mariscus*.
Schœnus.
Carex *stellulata*.
—— *Buxbaumii*.
—— *vulgaris*.
—— *Pyrenaica*.
—— *echinata*.
—— *canescens*.
As. Leersia *ciliaris*.
Alopecurus *geniculatus*.
Hierochloe *borealis*.
As. Eriochloa *annulata*. Trop.
As. Digitaria *ciliaris*.
—— *sanguinalis*.
As. Panicum *eruciforme*.
—— *miliaceum*.
—— *repens*.
As. Oplismenus *Crus-galli*.
As. Lappago *racemosa*. Trop.
As. Setaria *glauca*. Trop.
—— *viridis*.
As. Cenchrus. Trop.
Stipa.
As. Aristida. Trop.
As. Sporobolus *commutatus*. Tr.
—— *diander*.
Apera.
Agrostis.
Polypogon **Monspeliensis*.
Deyeuxia.
Phragmites *vulgaris*.
As. Dactyloctenium *Ægyptiacum*.
As. Cynodon *Dactylon*.
Deschampsia *cæspitosa*.
Trisetum *subspicatum*.
As. Eragrostis. Trop.
Glyceria *fluitans*.
Kœleria *cristata*.
Festuca *duriuscula*.
—— **bromoides*.
Bromus *commutatus ?*
Poa.
Triticum.
*Hordeum.
As. Imperata *arundinacea*.
As. Anthistiria. Trop.
As. Andropogon. Trop.
As. Chrysopogon. Trop.
As. Sorghum *Halepense*. Trop.
As. Ischæmum. Trop.
Lepturus *incurvatus ?*
As. Ophiurus. Trop.
As. Rottbœllia. Trop.
As. Hemarthria. Trop.

Of the 227 genera and 148 species here enumerated, by far the larger proportion are natives of many other parts of the globe, including all those found also in Tropical India, but there is still left a list of 38 species so notably characteristic of northern Europe, and so rare, if present at all, in warm or southern Asia, that they at once challenge further investigation. These are, excluding such marsh- and water-plants as *Potamogeton, Scirpus, Isolepis, etc.*, and others, which inhabit all hot countries as well as cold :—

Draba *nemoralis.* All Europe, and Russian Asia.
Cardamine *pratensis.* Europe, Russian Asia, and Arctic America.
Hutchinsia *procumbens.* Europe, Western Asia, Mediterranean, Patagonia.
Sisymbrium *thalianum.* Europe, Russian Asia, and North America.
Stellaria *glauca.* Europe, Russian Asia, and North America.
Sagina *procumbens.* Europe, Russian Asia, Himalaya, North America, Fuegia.
Geranium *dissectum.* Europe, Russian Asia, North America, Fuegia.
Lotus *corniculatus.* Europe, Russian Asia.
Geum *urbanum.* Europe, Russian Asia, Himalaya, New Zealand, Fuegia.
Potentilla *anserina.* Europe, Russian and Central Asia, N. America, Arc. & Antarc. regions, N. Zeal.
Alchemilla *arvensis.* Europe, Western Asia.
Alchemilla *vulgaris.* Northern and Arctic Europe and Asia, Ceylon, and Peninsula of India.
Epilobium *tetragonum.* Temperate and Subarctic Europe, Asia, and N. and S. America, N. Zealand.
Lythrum *Salicaria.* Europe, North and Central Asia, North and South America, and South Africa.
Montia *fontana.* Europe, North Asia, North American Andes, New Zealand, Kerguelen's Land.
Sium *latifolium.* Europe, North Asia.
Bidens *cernua.* Europe, North Asia, Himalaya, North America.
Picris *hieracioides.* Europe, Central Asia, Himalaya, New Zealand.
Calystegia *sepium.* Temperate Europe, North Asia, North America, New Zealand, Fuegia.
Prunella *vulgaris.* Temperate Europe, Asia, North America, Himalaya.
Lycopus *Europæus.* Temperate Europe, Asia, North America, Himalaya.
Lysimachia *vulgaris.* Northern Europe and Russian Asia.
Samolus *Valerandi.* Europe, North Asia, Temperate and Tropical North and South America, Fuegia.
Alisma *Plantago.* Northern and Arctic Europe, Asia, America, and North-west India.
Actinocarpus *Damasonum*, var.? (*A. Damasonum*, in South-west Europe, Central Asia).
Juncus *communis.* Temperate northern hemisphere, India, South Africa, New Zealand.
Juncus *bufonius.* Temperate northern hemisphere, India.
Juncus *maritimus.* Temperate and North Europe, Asia, North America, New Zealand, Fuegia.
Luzula *campestris.* Temperate and Arctic Europe, Asia, America, New Zealand.
Carex *stellulata.* Temperate and Arctic Europe, Asia, America, New Zealand.
Carex *Buxbaumii.* Northern and Arctic Europe, Asia, America.
Alopecurus *geniculatus.* Europe, North and Central Asia, New Zealand.
Hierochloe *borealis.* Arctic Europe, Asia, America, New Zealand.
Deschampsia *cæspitosa.* Northern and Arctic Europe, Asia, Fuegia, New Zealand.
Trisetum *subspicatum.* Arctic and Alpine Europe, North America, Asia, America, Antarctic regions.
Glyceria *fluitans.* Temperate and Arctic Europe, Asia, America.
Kœleria *cristata.* Central and South Europe, N. Asia, Temperate N. America, New Zealand, Fuegia.
Festuca *duriuscula.* Temperate Arctic Europe, America, northern Asia, Andes, New Zealand, Fuegia.

With one exception (*Trisetum subspicatum*) these are all British, a great many are the only examples of their genus in Australia, and only three are water-plants. None of them are found in any truly tropical climate, and a few only enter the temperate plains of north-western India. All of them are temperate plants in Australia, and several of them subalpine or alpine; few inhabit south-west Australia, and as a whole they are characteristic of the coolest parts of south-east Australia and Tasmania, the latter island alone possessing 28 out of the 37. New Zealand possesses 15 of them, and the Antarctic regions 13; but few are South African.

It is a singular fact that some of the best-marked of these plants do not inhabit any part of India, except the extreme north-western Himalaya, and others occur nowhere in the old world between northern Europe or Asia and Australia; one, *Alchemilla vulgaris*, though not Himalayan, is found on the Nilgiri mountains and those of Ceylon.

Neither New Zealand, temperate South America, nor South Africa, present so large an assemblage of well-marked European species, but these countries and the Antarctic islands contain several that are not found in Australia; and since we must look to one general cause for this southern migration of northern forms into all the south temperate lands, I shall add a list of all other such genera and species as are known to me.

Anemone.
*decapetala, L.* Fuegia.
Thalictrum. South Africa.
Berberis. Fuegia.
Corydalis. South Africa.
Fumaria. Ditto.
Draba.
*incana.* Fuegia.
Matthiola. South Africa.
Alyssum. Ditto.
Sinapis. Ditto.
Sisymbrium.
*Sophia.* Fuegia.
Reseda. South Africa.
Lychnis.
*apetala?* Fuegia.
Dianthus. South Africa.
Silene. Ditto.
Cerastium.
*arvense.* Fuegia, etc.
Althæa. South Africa.
Erodium. Ditto.
Impatiens. Ditto.
Trifolium. Ditto.
Vicia. Fuegia.
Lathyrus.
*maritimus.* Fuegia.
Fragaria. South Chili.
Hippuris.
*vulgaris, L.* Fuegia.
Crassula. South Africa.
Sempervivum. South Africa.
Cotyledon. Ditto.
Ribes. Fuegia.
Saxifraga.
*exarata.* Ditto.
Chrysosplenium. Ditto.
Sanicula. South Africa.
Bupleurum. Ditto.
Pimpinella. Ditto.
Œnanthe. Ditto.
Seseli. Ditto.
Athamanta. Ditto.
Ptychotis. Ditto.
Ferula. Ditto.
Peucedanum. Ditto.
Laserpitium. Ditto.
Trinia. Ditto.
Torilis. Ditto.
Conium. Ditto.
Osmorrhiza. Fuegia.
Galium.
*Aparine.* Ditto.
Rubia. South Africa.
Valeriana. Fuegia.
Scabiosa. South Africa.
Erigeron.
*alpinus.* Fuegia.
Aster. Ditto.
Chrysocoma. South Africa.
Inula. Ditto.
Pulicaria. Ditto.
Chrysanthemum.
Pyrethrum.
Artemisia. South Africa.
Tanacetum. Ditto.
Ligularia. Ditto.
Hypochœris. Ditto.
Lactuca. Ditto.
Hieracium. Ditto, Fuegia.
Taraxacum.
*Dens-leonis.* Fuegia, N. Zeal.
Erica. South Africa.
Gentiana.
*prostrata.* Fuegia.
Anchusa. South Africa.
Datura. Ditto.
Orobanche. Ditto.
Linaria. Ditto.
Veronica.
*Anagallis.* New Zealand.
Bartsia. South Africa.
Sibthorpia. Ditto.
Stachys.
*sylvatica?* Fuegia.
Marrubium. South Africa.
Leonotis. Ditto.
Sideritis. Ditto.
Galeopsis. Ditto.
Teucrium. Ditto.
Ocimum. Ditto.
Acanthus. Ditto.

Primula.
*farinosa.* Fuegia, etc.
Anagallis. S. Africa, Fuegia.
Statice.
Pinguicula. Fuegia.
*Armeria.* Ditto.
Plantago.
*maritima.* Ditto.
Emex. South Africa.
Polygonum.
*maritimum.* S. Africa, Fuegia.
Passerina. Ditto.
Mercurialis. Ditto.
Urtica.
*dioica.* Fuegia. (introd.?)
Salix. South Africa, Chili.
Myrica. Ditto.
Alnus. Ditto.
Empetrum.
*nigrum.* Fuegia, Trist. d'Acun.

Satyrium. South Africa.
Ruscus. Ditto.
Ornithogalum. Ditto.
Anthericum. Ditto.
Hyacinthus. Ditto.
Scilla. Ditto.
Allium. Ditto.
Sparganium.
*simplex.* New Zealand.
Lemna.
*gibba.* New Zealand.
Carex.
*festiva.* Fuegia.
*curta.* Ditto.
Phleum.
*alpinum.* Fuegia.
Alopecurus.
*alpinus.* Fuegia.
Phalaris. South Africa.

Agrostis.
*tenuifolia,* var. Fuegia.
*canina.* New Zealand.
Avena. Fuegia.
Aira.
*flexuosa.* Fuegia.
Poa.
*pratensis.* Ditto.
*nemoralis.* Ditto.
Dactylis. Ditto.
Catabrosa. Ditto.
Schismus. South Africa.
Melica. Ditto.
Secale. Ditto.
Triticum.
*caninum.* Fuegia.
Elymus. Ditto.
Hordeum.
*jubatum.* Ditto.

This catalogue adds many very northern genera to the southern Flora, chiefly from South Africa, and some very northern species, chiefly from Fuegia and the Antarctic islands; of the latter, the best-marked are the following, with their distribution:—

Anemone *decapetala.* Northern United States and Arctic circle, Peru, Chili, South Brazil.
Draba *incana.* Northern and Arctic Europe and Asia.
Sisymbrium *Sophia.* Europe, North Asia, Caucasus, Himalaya, North America, Fuegia, South Chili.
Lychnis *apetala.** Arctic Europe, Asia, and America, Altai and Himalaya.
Cerastium *arvense.* Europe, Russian Asia, North America.
Lathyrus *maritimus.* Arctic and North-western Europe, Arctic Asia and America.
Hippuris *vulgaris.* Europe, North and Central Asia, North America, and Arctic regions.
Saxifraga *exarata.* Alpine and Arctic Europe, Asia Minor, and North America.
Galium *Aparine.* All Europe, North and Central Asia, Himalaya, North America.
Erigeron *alpinus.* Alpine and Arctic Europe, Asia, and America.
Taraxacum *Dens-leonis.* Temperate and Arctic Europe, Asia, and America.
Gentiana *prostrata.* Alps of Central Europe and Asia, Himalaya, Rocky Mountains, and Andes of South America.
Stachys *sylvatica.*† Europe, North and Central Asia.
Veronica *Anagallis.* Europe, Central and North Asia, North America.
Primula *farinosa.* Northern and Arctic Europe, Asia, America.
Statice *Armeria.* Throughout North Temperate Zone to Arctic regions.
Plantago *maritima.* Europe, North and Central Asia, North and South America, South Africa.
Polygonum *maritimum.* Europe, North Asia, North America.
Empetrum *nigrum.* Northern and Arctic Europe, Asia and America.
Sparganium *simplex.* Northern and Arctic Europe, Asia and America.

* *L. Magellanica,* Lamk., Flor. Antarc., ii. 246.

† *S. Chonotica,* Flor. Antarc., ii. 336.

Carex *festiva*. Arctic North America, and Lapland.
Carex *curta*. Arctic and Alpine Europe, Asia, and North America.
Phleum *alpinum*. Arctic and Alpine Europe, Asia and America.
Alopecurus *alpinus*. Arctic and Alpine Europe, Asia and America.
Agrostis *canina*. Europe, North Asia, North America.
Aira *flexuosa*. Europe, North Asia, North America.
Poa *pratensis*. Temperate and Arctic Europe, Asia, North America.
Poa *nemoralis*. Northern and Arctic and Alpine Europe, Asia, Himalaya, North America.
Triticum *caninum*. Temperate and Arctic Europe and America, Central and Northern Asia.
Hordeum *jubatum*. Temperate North America.

Here are 30 species, of which the *Taraxacum* is found both in New Zealand and Fuegia, and the *Veronica Anagallis* and *Agrostis canina* in New Zealand only. If to this we add 12 from the Australian list of northern forms, which are also found in south Chili, or the Antarctic islands, we have two nearly equal lists of decidedly northern plants in the south temperate and colder zones, —one of the Old World, the other of the New; in which lists about one-third of the plants are common to both. I have no catalogue of the decidedly indigenous European plants in South Africa, and therefore cannot extend this subject by comparing the two south temperate divisions of the Old World Flora in respect of the northern plants they contain; but my impression is that though South Africa adds so many northern genera, it will fall short in number of nearer allied forms.

The last observation I shall make with reference to this subject is, that the existing European Flora does not contain one Australian representative, nor betray the remotest direct botanical affinity with the Australian. I have elsewhere indicated (p. xxi.) that there is evidence of what are now Australian plants having once inhabited Europe. In north-eastern Asia there are however a few Australian forms, of which the *Haloragis*, *Stylidium*, and *Bæckia* of China, the *Microtis* of Bonin, *Stackhousia* and *Thysanotus?* of Philippine Islands, *Thelymitra* of Java, and *Proteaceæ* of Japan are examples. Connecting these again is the singular assemblage of Australian forms on the lofty mountain Kini Balou in Borneo, and which consists of species of *Drimys*, *Leptospermum*, *Leucopogon*, *Coprosma*, *Didiscus*, *Drapetes*, *Euphrasia*, *Phyllocladus*, *Dacrydium*, and an Irideous and Restiaceous plant, both apparently allied to Australian genera.

## § 12.

### *On the Fossil Flora of Australia, and its Geology in relation to the Existing Flora.*

The fossiliferous rocks of Australia do not throw much light upon the antiquity of its existing Flora, because of the hiatus which geologists seem to consider exists between the palæozoic and tertiary strata of that country. Mr. Jukes* has called attention to the curious fact that this deficient series in Australia is largely developed in Europe, and there presents such Australian forms of life as marsupiate quadrupeds, *Trigonia* and other fossil shells, together with Cycadeous plants. To the latter no importance can be attached, as this Order is far more characteristic of tropical America, of India, and even of south-east Africa, than of Australia; but on the other hand the

* J. B. Jukes, 'Physical Structure of Australia,' p. 89, etc.

*Araucaria* of the English oolite, and other fossils alluded to at p. xxi., would seem to tend to confirm Mr. Jukes's observation.

The so-called Palæozoic rocks of Australia contain fossil plants of which so little, botanically, is known, that it would be rash to speculate on their affinities, even if we knew the age of the beds they are found in, as compared with the European, which we do not. Their fossils comprise Ferns of several genera, including the genus *Glossopteris,* which is found in the oolitic beds of England, and in India;* *Phyllotheca,* a plant somewhat similar to *Casuarina,* but of extremely doubtful affinity; *Vertebraria,* also an Indian fossil, as to the affinities of which no plausible guess has been made; *Sphenopteris* and *Zygophyllites,* of which little more can be said. To these the Rev. W. B. Clarke† adds the following well-known British coal fossils,—*Lepidodendron, Halonia, Sigillaria, Ulodendron, Calamites,* and *Stigmaria.*

Many of the tertiary fossil plants of Australia would seem to be very closely allied to existing ones; these include the *Casuarina* cones of Flinders Island, the *Banksia* and *Araucaria* wood of Tasmania, the *Banksia* cones of Victoria (which seem identical with those of *B. ericifolia,* though buried under many feet of trap). The leaves of the calcareous tuffs on the banks of the Derwent,‡ etc., appear however to belong to a different and warmer period.

From the above it would appear that the extinct Flora of Australia was not entirely different from that now existing, and, following Mr. Jukes's line of argument, that Australia continued as dry land during the European Oolitic and Cretaceous periods. At this epoch Mr. Jukes assumes that the peculiar Flora of Australia was introduced, and that the continent was again submerged during the Tertiary epoch, when it presented the appearance of two long islands, or chains of islands, one, the larger, representing the elevated land of eastern Australia and Tasmania, the other that of south-eastern Australia, together with subsidiary groups in the western and northern parts of the continent.

These are the speculations of an able geologist and voyager, which I introduce without comment, and chiefly to observe that such a partition of the continent may be supposed to be favourable to the multiplication of forms of vegetable life out of fewer pre-existing ones, by the segregation of varieties. These groups of islands would present a precise analogy with the Galapagos and Sandwich groups, where we have the small islands of one Archipelago peopled by different species, and even genera. The subsequent elevation of these islets, and consequent union of them into larger ones, would further, according to Darwin's hypothesis (of the struggle of very different kinds of species and families for occupation of the soil resulting in a further separation of varieties into species), tend to enlarge the genera numerically within comparatively small geographical limits, and thus effect such a geographical distribution of plants as Australia now presents.

In our complete ignorance as to the condition of all the continents during the Palæozoic epoch, it is impossible to speculate on the earlier condition of the Australian Flora. That previous to some Tertiary submersion of a great part of the continent, it was not altogether specifically different from what it now is, would appear from a fact insisted on by Mr. Jukes, that it was during such a submersion that those volcanos were active, the lavas of which now cover large tracts of southern Australia, and which we know to have buried a plant apparently identical with *Banksia ericifolia,* which is still one of the commonest trees in that part of the country: but the question of where the *Banksias* and their allies were created, and, if in other lands than Australia, how they migrated thither, we have no

* M'Coy in Ann. Nat. Hist. vol. xx. p. 152. † Journ. Geolog. Soc. Lond. vol. iv. p. 60.

‡ Darwin's Journal, p. 535, and Volcanic Islands, p. 140; Strzelecki, p. 254; Milligan in Tasman. Journ. i. 131.

means of answering. If the identifications of *Banksia* and other Proteaceous leaves in the Cretaceous and Miocene formations of Europe are worthy of any confidence, it is possible that the Australian from the northern to the southern hemisphere, as, according to Darwin's types may have migrated speculations, the existing European plants in Australia have.

Some arguments in favour of the antiquity of the Australian Flora as compared with the European may be derived from a consideration of its generic and ordinal peculiarities. If, as I have expressed it, a Genus or Order is rendered peculiar, that is, unlike its allies, by the extinction of the intermediate species, it follows that the greater the peculiarity the greater the number of lapsed forms. Applying this argument to the Australian Flora, we must assume an extraordinary destruction of species that once linked it with the general Flora of the globe, to account for its many peculiar genera, and these being represented by so many species. But as this destruction of species is primarily due to geological causes, that influence climates and so directly and indirectly lead to the extinction of species, and as geological events are of slow progress, it follows that we must regard the Australian Flora as a very ancient one. Again, Darwin argues that a rich Flora or Fauna, marked by a preponderance of highly developed types, must have required a large area for its development: this is because, according to his view, the principle of natural selection favours the high forms, and is unfavourable to the low. Now it could be easily shown that the Australian Flora is of as high a type as any in the globe, but under existing conditions has a very small area for its development, and presents fewer representatives of other Floras to contend with than most; and we must hence, under these hypotheses, assume not only the antiquity of the Flora, but that it was developed in a much larger area than it now occupies.

The only other geological speculation, founded upon anything like plausible grounds, that bears upon the origin of any of the plants now inhabiting Australia, is that of Mr. Darwin in reference to the European species, to which I have alluded at p. xvii. It implies of course that the existing European types were introduced into the continent long subsequently to the peculiar Australian, and are plants of a later creation. I have already pointed out the difficulties attending its adoption, the chief of which is the admission of such a cold climate in the intertropical latitudes as that not merely a temperate, but a decidedly northern Flora should have migrated across them; and that this migration, if conceded, must have been extensive and have introduced very many genera and species into the tropics appears likely, when we consider the fragmentary character of the assemblage of northern forms still left in Australia,—for even when reduced to its most typical examples, it consists of nearly as many Natural Orders as species. The little colony of south Australian genera found under the Equator, on Kini Balou, in Borneo, presents another difficulty, except indeed it be regarded as evidence of that previous southern migration of Australian forms from Europe to Australia, which I have just mentioned as conceivable.

There are then the Antarctic types to account for; were they of more recent introduction than the European or Australian? Darwin has alluded to the possibility of these having been transported by icebergs from higher southern latitudes, during a period of greater cold than now obtains in the southern hemisphere, (as the Scandinavian and Arctic plants are supposed by Forbes to have been transported to Britain, etc., during the Glacial period), and, with the north European plants already in Australia, to have ascended the mountains during the subsequent rise of temperature. This would imply that Australia was, during a cold Tertiary period, simultaneously peopled by all those Antarctic, European, and Australian types which now inhabit it, but that the latter Flora was much less developed in number of species and genera than now; for I cannot but regard the Antarctic Flora in the same light as the European, and as a mere fragment of a much more extensive one, whose other members perished in the battle for place waged with the European and Australian during those changes of climate and level that succeeded their first introduction. The ultimate numerical ascendency of the Australian botanical element may have been gained during the subsequent partition of the continent into archipelagos of islands, which became so many colonies of Australian types of vegetation, prepared on the final rise of the land to descend and occupy the intermediate ground. The paucity of alpine plants of Australian genera is a fact which lends itself well to this idea; it implies that, during either the rise of land or increase of temperature, the tendency of the species of Australian type was to seek warmer regions, and that the boreal and antarctic types being better suited to a colder climate prevented to a great extent the establishment of such varieties of Australian type as might otherwise have been adapted to inhabit the same climate as themselves.

When I take a comprehensive view of the vegetation of the Old World, I am struck with the appearance it presents of there being a continuous current of vegetation (if I may so fancifully express myself) from Scandinavia to Tasmania; along, in short, the whole extent of that arc of the terrestrial sphere which presents the greatest continuity of land. In the first place, Scandinavian genera, and even species, reappear everywhere from Lapland and Iceland to the tops of the Tasmanian alps, in rapidly diminishing numbers it is true, but in vigorous development throughout. They abound on the Alps and Pyrenees, pass on to the Caucasus and Himalaya, thence they extend along the Khasia mountains, and those of the peninsulas of India to those of Ceylon and the Malayan archipelago (Java and Borneo), and after a hiatus of 30°, they appear on the alps of New South Wales, Victoria, and Tasmania, and beyond these again on those of New Zealand and the Antarctic Islands, many of the species remaining unchanged throughout! It matters not what the vegetation of the bases and flanks of these mountains may be; the northern species may be associated with alpine forms of Germanic, Siberian, Oriental, Chinese, American, Malayan, and finally Australian and Antarctic types; but whereas these are all, more or less, local assemblages, the Scandinavian asserts his prerogative of ubiquity from Britain to beyond its antipodes.

Next in importance and appearance along the arc indicated is that Flora which may be called Himalayan,* and which consists of the endemic plants of that range, with a mixture of Siberian, Caucasian, and Chinese genera; this, gathering strength in its progress south-eastward along the ranges of northern and eastern India, occupies the flanks of all the mountain-chains I have enumerated between the Caucasus and Malay Islands; but there the Himalayan Flora disappears, and does not reappear in Australia or New Zealand, and scarcely a trace of it is found in Polynesia.

The Malayan Flora† is in many respects closely allied to the Himalayan, but is wholly tropical in character. This also very gradually appears in the valleys of the western and central Himalaya, and multiplying in genera and species in the eastern Himalaya and Khasia ranges, it sweeps down the Malayan peninsula, occupies all the Malayan Islands, and then it too stops short without entering Australia, being, however, continued eastward in tropical Polynesia.

Lastly, there is the Flora of the plains and lower hills of India,‡ which is of a drier character than the Malayan, and is equally characteristic of Africa. This commences gradually in north-west India, or even in eastern Persia, and occupies all central India, the Gangetic plain, the whole of the

* Characterized by *Cupuliferæ*, *Magnoliaceæ*, *Ternstrœmiaceæ*, *Laurineæ*, *Balsamineæ*, *Ericeæ*, *Fumariaceæ*, etc.

† *Vaccineæ*, *Rhododendron*, *Begoniaceæ*, *Quercus*: and equally typified by *Cyrtandraceæ*, *Dipterocarpeæ*, *Myristiceæ*, *Anonaceæ*, *Menispermeæ*.

‡ It consists of *Acanthaceæ*, *Sterculiaceæ*, and other Orders, enumerated at p. xlii. *et seq.*

Madras peninsula, except the western coast and mountains, the valley of the Irrawaddi, and the lower flat districts of the Malay Islands, whence it is continued in great force over the whole of tropical Australia.

Reversing the position, and beginning at the southern extreme of this arc of vegetation, there is first the Antarctic Flora (the complement of the Scandinavian), with its decided Australian representatives in *Centrolepideæ* and *Stylidieæ*, commencing in Fuegia, the Falklands, and Lord Auckland's and Campbell's group, reappearing in the alps of New Zealand, Tasmania, and Australia, and disappearing under the equator, on the alps of Borneo, being thus strictly confined to the southern hemisphere. Next there is the Australian Flora proper, a large and highly developed one, diminishing rapidly after crossing the southern tropic, and as it advances towards the north-western shore of the continent, reappearing in very small numbers in the Malay Islands, and terminated by a *Casuarina* on the east coast of the Bay of Bengal, and a *Stylidium* on the west. Not one representative of this vegetation advances further north-west.

Analogous appearances are presented by Africa and America. In Africa Indian forms prevail throughout the tropics, and, passing southwards, occupy the northern boundary of the south temperate zone; but there a very copious and widely different vegetation succeeds, of which but few representatives advance north to the tropic, and none to India, but with which are mingled Scandinavian genera and even species. In the New World, Arctic, Scandinavian, and North American genera and species are continuously extended from the north to the south temperate and even Antarctic zones; but scarcely one Antarctic species, or even* genus (*Forstera, Calceolaria, Colobanthus, Gunnera,* etc. etc.) advances north beyond the Gulf of Mexico.

These considerations quite preclude my entertaining the idea that the Southern and Northern Floras have had common origin within comparatively modern geological epochs; on the contrary, the European and Australian Floras seem to me to be essentially distinct, and not united by those of intervening countries, though fragments of the former are associated with the latter in the southern hemisphere. For instance, I regard the Indian plants in Australia to be as foreign to it, botanically, as the Scandinavian, and more so than the Antarctic; and that to whatever lengths the theory of variation may be carried, we cannot by it speculate on the Southern Flora being directly a derivative one from the existing Northern. On the contrary, the many bonds of affinity between the three southern Floras, the Antarctic, Australian, and South African, indicate that these may all have been members of one great vegetation, which may once have covered as large a southern area as the European now does a Northern. It is true that at some anterior time these two Floras may have had a common origin, but the period of their divergence antedates the creation of the principal existing generic forms of each. To what portion of the globe the maximum development of this Southern Flora is to be assigned, it is vain at present to speculate; but the geographical changes that have resulted in its dismemberment into isolated groups scattered over the Southern Ocean, must have been great indeed. Circumscribed as these Floras are, and encroached upon everywhere by northern forms, their ultimate destiny must depend on that power of appropriation in the strife for place which we see in the force with which an intrusive foreign weed establishes itself in our already fully peopled fields and meadows, and of the real nature of which power no conception has been formed by naturalists, and which has not even a name in the language of biology. Everywhere, however, we see the more widely distributed, and therefore least peculiar forms of plants, spreading, and the most peculiar dying out in small areas, and the progress of civilization has introduced in man a new enemy to

* *Acæna* is a remarkable exception. See p. xc. in note.

the scarce old forms, and a strong ally of those already common: nor can it be doubted but that many of the small local genera of Australia, New Zealand, and South Africa, will ultimately disappear, owing to the usurping tendencies of the emigrant plants of the northern hemisphere, energetically supported as they are by the artificial aids that the northern races of man afford them.

## § 14.

### *On some of the Naturalized Plants of Australia.*

My sources of information upon this subject are unfortunately extremely scanty, and almost confined to data procured from the vicinity of Melbourne, where Mr. Adamson has paid especial attention to the introduced species which have run wild, and assumed the positions and importance of native plants. It would be interesting to discover the date and particular circumstances under which these plants were introduced, and so to register their increase and migrations as to afford to succeeding observers the means of comparing their future condition with their present. In the early times of a colony, there is comparatively little difficulty in distinguishing the colonists from the native species; but as the surface of the land becomes artificially disturbed, the habits of all its plants are influenced,—the endemic species are driven from their native places, and take refuge in hedgerows, ditches, and planted copses, and from there associating with the introduced plants, are apt to be classed in the same category with them; whilst the introduced wander from the cultivated spots and eject the native, or, taking their places by them, appear, like them, to be truly indigenous.

There are many interesting subjects of inquiry connected with this replacement of one vegetable by another, such as determining the relations between the facility with which the new plants of certain countries or genera are introduced and establish themselves, and the countries such plants come from, or Floras of which they form a part.* Much of course depends on the new comer finding a suitable climate and soil for its future increase, but there may be more in the physique or constitution of the new comer that enables it to displace other plants which are apparently equally well (if not better) adapted to the circumstances it finds itself environed with. The nature of the past intercourse between Europe and Australia should lead us to anticipate that a far greater number of English plants are naturalized in Australia than of Australian in England; but the fact of importation does not explain naturalization, nor how it is that no Australian plant has become naturalized in England. This total want of reciprocity in migration is no doubt mainly attributable to climate, but then we have the apparent double anomaly, that Australia is better suited to some English plants than England is, and that some English plants are better suited to Australia than those Australian plants were which have given way before English intruders. For my own part, I am disposed to consider that the three elements of (1) abundant exportation of seed from Europe into Australia for agricultural and horticultural purposes, and scanty export of Australian seed produce to England; (2) better adaptation of Australia than England to support numerous forms of vegetable life; and (3) abundance of unoccupied ground in Australia as compared with England; are, combined, all but sufficient to account for the predominance of so many European naturalized plants in Australia, and for the converse state of things in England. But I think it may still remain to be seen whether the altered

* The reader will find some admirable discussions on this and kindred subjects in the chapters of A. De Candolle's 'Géographie Botanique Raisonnée' devoted to naturalized and introduced plants.

circumstances which seem to be temporarily favourable will prove to be so permanently: perhaps they over-stimulate, and will, by gradually effecting a change on the constitution of the naturalized plants, either render them eventually distinct forms, or bring on degeneracy and consequent extinction.

In all these discussions it must be borne in mind that no wild species is stationary in number of individuals. None will survive all time; each must reach a period of maximum development, and decline from it to extinction; and as we do not know that man can add to or take from the sum of vegetable matter on the globe, it may very well be the case, that in every instance where his operations tend to an inordinate development of a species in individuals, he is shortening the period of time otherwise allotted for the duration of that species. Man, as I have observed before (p. viii. in note), may hasten or retard the operations of Nature, but cannot reverse them.

The following list refers almost entirely to Melbourne, a colony established about twenty years ago. I have no such list of the introduced plants of any other Australian colony, and the scattered notices of naturalized plants that I have met with in various travels, are not sufficiently definite to be quoted. Thus, in Mitchell's first journey, I find a singular observation, that Horehound and common Grass, or Dog-tooth Grass, spring up wherever the white man sets his foot, by which I assume that the *Marrubium* and *Cynodon* are meant, but cannot be sure.

*Catalogue of some of the Naturalized Plants of the Australian Colonies, (chiefly compiled from the Melbourne collections and notes of F. Adamson, Esq.,) to which are added the species enumerated in Mueller's Reports, and Backhouse's and Gunn's MSS.*

The letter A indicates that the species is also naturalized in the northern United States, according to Professor Asa Gray's Manual.

A 1. Ranunculus *acris*, L. Very common at Melbourne. (Britain, pastures.)
A 2. Ranunculus *sceleratus*, L. Victoria. (Britain, pastures, ditches.)
A 3. Ranunculus *muricatus*, L. Victoria. (Europe, cornfields.)
A 4. Delphinium *Consolida*, L. New South Wales. (Europe, cornfields.)
5. Papaver *album*, L. New South Wales. (Europe.)
A 6. Papaver *dubium*, L. New South Wales. (Britain.)
7. Escholtzia *Californica*, Cham. Victoria. (California.)
A 8. Argemone *Mexicana*, L. New South Wales. (South United States.)
A 9. Fumaria *officinalis*, L. (Britain, waste places.)
A 10. Barbarea *præcox*, L. An overpowering weed in Tasmania, *Backh.* (Britain, hedges, etc.)
A 11. Nasturtium *officinale*, L. (Britain, water plant.)
A 12. Sisymbrium *officinale*, L. Victoria. (Britain, roadsides.)
A 13. Capsella *Bursa-pastoris*, L. Ubiquitous. (Britain, waste places.)
14. Lepidum *sativum*, L. New South Wales. (South Europe.)
A 15. Lepidum *ruderale*, L. Victoria. (Britain, waste places.)
A 16. Senebiera *didyma*, Pers. Victoria, Tasmania. (Britain, waste places.)
A 17. Raphanus *Raphanistrum*, L. Victoria. Sometimes colouring the cornfields pink, *Adamson*. (Britain, weed of culture.)
A 18. Brassica *Napus*, L. Tasmania. (Britain, weed of culture.)
A 19. Sinapis *arvensis*, L. Tasmania. (Britain, weed of culture.)
20. Malva *pusilla*, With. Grows to a great size (2 feet) in cultivated ground, looking very different from its usual small state. Victoria, *Adamson*. (Europe.)
A 21. Malva *sylvestris*, L. Victoria and Tasmania. (Britain, roadsides.)

A 22. Malva *crispa*, L. Victoria. (Central Europe, fields and waste places.)
A 23. Malva *rotundifolia*, L. Tasmania. (Britain, fields and waste places.)
24. Silene *Gallica*, L. Victoria. (South Europe, weed of cultivation.) Var. *quinquevulnera*. Victoria and Tasmania. (South Europe, weed of cultivation.)
25. Cerastium *glomeratum*. Victoria. (Britain, waste places.)
A 26. Cerastium *vulgatum*, L. Victoria and Tasmania. (Britain, waste places.)
A 27. Sagina *apetala*, L. Victoria. (Britain, waste places.)
A 28. Stellaria *media*, L. Ubiquitous. (Britain, weed of cultivation.)
A 29. Spergula *arvensis*, L. Ubiquitous. (Britain, weed of cultivation.)
A 30. Linum *usitatissimum*, L.? Sparingly, and never far from cultivated ground, *Adamson*. (Britain, weed of cultivation.)
A 31. Erodium *cicutarium*, L. Tasmania. (Britain, waste places.)
32. Erodium *moschatum*, L. Adamson considers this to be decidedly indigenous on sandhills near the sea, whence it has spread to cultivated grounds, assuming a very large size and different form. Mueller notes it as an introduced plant. (Britain, waste places.)
33. Geranium *molle*, L. Tasmania. (Britain, pastures.)
A 34. Melilotus *officinalis*, L. (Britain, waste places.)
A 35. Melilotus *alba*, Lam. (Britain, waste places.)
36. Lathyrus *odoratus*, L. (South Europe, garden plant.)
37. Lathyrus *latifolius*, L. (South Europe, garden plant.)
A 38. Trifolium *repens*, L., has spread most luxuriantly wherever there is moisture, often destroying all other vegetation. (Britain, pastures.)
A 39. Trifolium *pratense*, L. Tasmania. (Britain, pastures.)
A 40. Trifolium *procumbens*, L. (Britain, pastures.)
41. Trifolium *filiforme*, L. (Britain, waste places.)
A 42. Medicago *sativa*, L. (South Europe, waste places.)
A 43. Medicago *lupulina*, L. New South Wales. (Britain, waste places.)
44. Lotus *tenuifolius*, Presl. Victoria. (South Europe, fields and hedges.)
45. Lotus *corniculatus*, L. Victoria. (Britain, fields and hedges.)
46. Vicia *angustifolia*, Roth. (Germany, fields and hedges.)
A 47. Vicia *sativa*, L. New South Wales. (Britain, fields.)
A 48. Ervum *hirsutum*, L. (Britain, fields.)
49. Lupinus *polyphyllus*, Dougl. New South Wales. (California, garden plant.)
50. Psoralia *pinnata*, L. Swan River. (Cape of Good Hope.)
51. Ulex *Europæus*, L. Naturalized about Hobarton, *Backh.* (Britain. Naturalized in St. Helena and Nilgherry mountains.)
52. Amygdalus *Persica*, L. New South Wales. (Persia.)
A 53. Rosa *rubiginosa*, L. Forms thickets in Tasmania; also common in Victoria. (Britain.)
A 54. Alchemilla *arvensis*, Lam. (Britain, weed of cultivation.)
55. Poterium *Sanguisorba*, L. (Britain.)
A 56. Lythrum *hyssopifolium*, L. In the streets of Sydney. (South Europe.)
57. Œnothera *suaveolens*, Desf. (North America.)
58. Polycarpon *tetraphyllum*, L. Ubiquitous. (South Europe.)
A 59. Portulaca *oleracea*, L. Victoria, New South Wales. (Tropics.)
60. Fœniculum *vulgare*, L. Victoria, New South Wales. (South Europe, garden plant.)
A 61. Pastinaca *sativa*, L. Victoria. (Britain, fields.)
62. Sherardia *arvensis*, L. Tasmania. (Britain, fields and waste places.)

63. Scabiosa *atro-purpurea*, L. Thoroughly established at Melbourne, *Adamson*. (South Europe, garden plant.)
64. Bellis *perennis*, L. Tasmania, in old gardens only. (Britain.)
65. Conyza *ambigua*, DC. (Europe, fields and waste places.)
66. Erigeron *Canadensis*, L. Ubiquitous. (United States.)
67. Bidens *tripartita*, L. (Britain.)
68. Chrysanthemum *segetum*, L. (Britain, weed of culture.)
69. Siegesbeckia *orientalis*, L. Ubiquitous weed of tropics. (India.)
70. Eclipta *erecta*, L. Ubiquitous weed of tropics. (India.)
71. Galinsoga *parviflora*, Cav. New South Wales. (South America.)
72. Pyrethrum *inodorum*, L. Tasmania. (Britain, weed of cultivation.)

A 73. Anthemis *Cotula*, L. Victoria. (Britain, weed of cultivation.)

74. Gnaphalium *luteo-album*, L. Forms a dense crop on newly turned-up land, to the exclusion of everything else. (Ubiquitous.)
75. Cryptostemma *calendulaceum*, Br. Abundant at Perth, *Harvey*. (South Africa.)
76. Carthamus *tinctorius*, L. (India, cult.)

A 77. Onopordon *Acanthium*, L. (South Europe, cult.)

A 78. Cnicus *lanceolatus*, L. Found at Melbourne, but has not spread much, *Adams*. A pest in Tasmania. (Britain, fields and roadsides.)

A 79. Cnicus *arvensis*, Hoffm. Also a pest in Tasmania. (Britain, fields and roadsides.)

80. Cnicus *palustris*, Willd. Common in Tasmania. (Britain, meadows, etc.)
81. Carduus *Marianus*, L., has spread amazingly along the great road up-country, and at Melbourne, preferring the richest soils, *Adams*. Also a pest in Tasmania, *Harvey*. (South Europe.)
82. Cynara *Scolymus*, L. (South Europe.)

A 83. Centaurea *solstitialis*, L. Victoria. Very abundant in certain places, but never far from cultivation, *Adams*. (South Europe, fields and waste places.)

84. Tragopogon *porrifolium*, L. Victoria. (South Europe, fields and waste places.)
85. Lapsana *pusilla*, L. So thoroughly introduced into Tasmania as to be apparently indigenous, *Gunn*. (Britain, fields.)
86. Hypochœris *glabra*, L. Victoria, Tasmania. (Britain, fields.)

A 87. Taraxacum *Dens-leonis*, Desf. Victoria, common. (Britain, ubiquitous in cultivated ground, etc.)

A 88. Sonchus *asper*, Vill. Victoria, Tasmania. (Britain, ubiquitous in cultivated ground, etc.)

A 89. Sonchus *oleraceus*, L. Growing everywhere, even on the roofs of houses in Melbourne, *Adamson*. (Britain, ubiquitous in cultivated ground, etc.)

A 90. Sonchus *arvensis*, L. (Britain, ubiquitous in cultivated ground, etc.)

A 91. Apargia *autumnalis*, Willd. (Britain, ubiquitous in cultivated ground, etc.)

A 92. Xanthium *spinosum*, L. First observed in April, 1857, in isolated patches near Melbourne. I am informed that it also first appeared in great quantities in the present year, at Queenscliff, near the Heads, *Adamson*.

93. Gorteriæ species? Spreading with great rapidity around Melbourne; growing 2–3 feet high, and destroying all other vegetation. Fortunately cattle are very fond of it, *Adamson*. (Cape of Good Hope.)

A 94. Melissa *officinalis*, L. (South Europe, hedges, etc.)

A 95. Origanum *vulgare*, L. (Britain, hedges and waste places.)

A 96. Marrubium *vulgare*, L. (Britain, fields and roadsides.)

A 97. Stachys *arvensis*, L. (Britain, fields and roadsides.)
98. Echium *violaceum*, L. New South Wales. (South Europe, waste places.)
A 99. Lithospermum *arvense*, L. Tasmania. (Britain, weed of culture.)
A 100. Echinospermum *Lappula*, Sw. (South Europe.)
101. Verbena *Bonariensis*, L. New South Wales. (South America.)
102. Solanum *Sodomæum*, L. (South Europe.)
A 103. Datura *Tatula*, L. (South Europe.)
A 104. Verbascum *Blattaria*, L. (Britain, waste places.)
105. Verbascum *virgatum*, With. (Britain.)
106. Celsia *Cretica*, L. (South Europe.)
A 107. Veronica *peregrina*, L. (South Europe.)
A 108. Veronica *serpyllifolia*, L. (Britain, fields and waste places.)
A 109. Anagallis *arvensis*, L. Common on cultivated ground, and has also spread into native pastures, *Adamson*. (Britain, weed of cultivation.)
A 110. Plantago *major*, L. (Britain, weed of cultivation.)
A 111. Plantago *lanceolata*, L. (Britain, weed of cultivation.)
112. Plantago *Coronopus*, L. Tasmania. (Britain, generally maritime.)
A 113. Polygonum *Convolvulus*, L. Victoria, Tasmania. (Britain, weed of cultivation.)
A 114. Polygonum *aviculare*, L. Very abundant about Victoria. I have seen newly turned-up soil covered with a thick matting of it. Cattle eat it with avidity, *Adamson*. (Britain, weed of cultivation.)
A 115. Rumex *Acetosella*, L. This often monopolizes the pastures about Melbourne, to the entire exclusion of the Grasses, *Adamson*. (Britain, weed of cultivation.)
A 116. Rumex *crispus*, L. (Britain, weed of cultivation.)
A 117. Urtica *dioica*, L. Only seen at Melbourne where houses are or have been, *Adamson*. (Britain, chiefly near houses.)
A 118. Urtica *urens*, L. (Britain, chiefly near houses.)
A 119. Chenopodium *viride*, L. Tasmania. (Britain, chiefly near houses.)
120. Atriplex patula, L. (Britain, chiefly maritime.)
A 121. Euphorbia *helioscopia*, L. (Britain, weed of cultivation.)
A 122. Alopecurus *geniculatus*, L. (Britain, weed of cultivation.)
A 123. Anthoxanthum *odoratum*, L. (Britain, weed of cultivation.)
124. Phalaris *minor*, Retz. (South Europe, weed.)
A 125. Phalaris *Canariensis*, L. (South Europe, weed.)
A 126. Holcus *lanatus*, L. (Britain, weed.)
A 127. Polypogon *Monspeliensis*, Desf. (South Europe, waste places.)
128. Avena *fatua*, L. (Britain, weed of cultivation.)
A 129. Dactylis *glomerata*, L. (Britain, fields and waste places.)
A 130. Poa *annua*, L. Ubiquitous. (Britain, weed of cultivation.)
A 131. Briza *media*, L. Victoria, Tasmania. (Britain, weed of cultivation.)
132. Briza *minor*, L. (Britain, weed of cultivation.)
133. Festuca *Myurus*, L. Ubiquitous. (Britain, weed of cultivation.)
A 134. Bromus *sterilis*, L. Victoria. (Britain, weed of cultivation.)
A 135. Bromus *commutatus*, L. Victoria. (Britain, weed of cultivation.)
A 136. Lolium *perenne*, L. Victoria, Tasmania. (Britain, weed of cultivation.)
A 137. Lolium *temulentum*, L. Victoria. (Britain, weed of cultivation.)
138. Hordeum *murinum*, L. Victoria. (Britain, roadsides.)
139. Lepturus *incurvatus*, L. Victoria, Swan River. (Britain, salt-marsh.)

## § 15.

### *A List of some of the Esculent Plants of Australia.*

In the course of reading preparatory to undertaking this Essay, I found scattered notices of edible and other plants, which I thought might be worth bringing together, and thus form the skeleton of an Australian 'Flora Cibaria,' for the use of future inquirers. It is extremely incomplete as an exposition of the uses to man of the Australian Flora, both because it omits many plants that have escaped my notice or memory, more that I know nothing of, and perhaps a still greater number that come under the category of being "eatable but not worth eating." I have not alluded to pharmaceutical plants: such may exist, and multitudes of the weeds, seeds, and roots of Australia will no doubt enjoy a more or less substantial reputation as drugs, for a period, and then be consigned to oblivion. This is the pharmaceutical history of the plants of all countries that have been long inhabited by civilized man, and Australia will form no exception to them. The fact being, that of the multitude of names of plants that appear in Pharmacopœias, the number of really active and useful plants, known to be such, is extremely small.

I have been greatly indebted to Backhouse's Notes on the Edible Plants of Tasmania (Ross, 'Hobarton Almanack'), and to Gunn's and Mueller's various writings, for much of the following information.

Atherosperma moschata. Bark used as tea in Tasmania.
Tasmania aromatica. "Pepper-tree." Drupe used as condiment.
Cardamine hirsuta. This and other species afford excellent pot-herbs when luxuriant and flaccid.
Nasturtium terrestre. Ditto.
Nymphæa gigantea, and another species. Roots and fruit eaten.
Nelumbium speciosum. Seeds eaten raw, and roasted as coffee.
Hibiscus, allied to heterophyllus? Yields a sorrel.
Billardiera mutabilis. Berries acid and pleasant.
Pittosporum acacioides. Yields an excellent gum.
Vitis sp. Tubers and fruits eaten.
Meliaceæ. Various species of *Trichilia?* bear acidulous drupes.
Wallrothiæ sp. Fruit edible.
Triphasia glauca. A small lemon, *Mueller.*
Oxalidis sp. Leaves acid (sorrel).
Geranii spp. parviflorum, and others. Roots eaten by Natives.
Adansonia Gregorii. Dry, acidulous pulp of fruit eaten.
Bombax. Wood used for boats.
Brachychiton sp. Wood full of mucilage; seeds eatable, and make a good beverage.
Coræa alba. Cape Barren Tea.
Castanospermum edule. Moreton Bay Chesnut.
Acacia. Various species yield excellent eating gum, as *A. mollissima*, of which the gum is soft and sweet.
Acacia Sophoræ. Seeds eaten by natives of Tasmania. "Boobyalla."
Acacia pendula. Myall, cattle are fed on its leaves, *Mitchell.*
Erythrina. Wood used for shields and boats.
Canavalia Baueriana. The Mackenzie Bean.

Trigonella suavissima. Excellent spinach, *Mitchell.*
Rubus Gunnianus. The best native fruit in Tasmania.
Parinarium. The Nonda fruit of Leichardt, *Mueller.*
Terminalia. Fruit eaten; gum also eaten.
Jambosa eucalyptoides? Rose-apple.
Leptospermum. Leaves of various species used for tea.
Eugeniæ sp. White apple of tropics, East Australia.
Eucalyptus dumosa, and others? Water contained in roots: native name, "Weir-malleè." Also yields a kind of manna, called Lerp, or Laap (the nidus of an insect), consisting of starch.
Eucalyptus mannifera. Manna formed on leaves.
Eucalyptus Gunnii. Cider-tree of Tasmania.
Portulaca oleracea. Purslane; acidulous pot-herb.
Nitraria Billardieri. Fruit eatable, *Mueller.*
Tetragonia expansa. New Zealand spinach.
Mesembryanthemum præcox. Fruit eatable, *Mueller.*
Mesembryanthemum æquilaterale. "Pigs'-faces." Fleshy fruit eaten. "Canajong" of natives of Tasmania.
Sambucus Gaudichaudiana. Fruit fleshy, sweetish.
Cucumis pubescens. Fruit abundantly eaten.
Lagenaria vulgaris? Gourds used for bottles, etc.
Rhizophora?, Kandelia, etc. Wood used for canoes; young shoots beaten into a paste and eaten.
Gardenia edulis. Leichardt's "Bread-tree," *Mueller.*
Coprosma hirtella. Fruit sweet, eatable, not agreeable.
Coprosma microphylla and C. nitida. Native currant; fruit good.
Sonchus asper. Stems and roots eaten.
Microseris. Roots used roasted by the Natives.
Mimusops Kauki. Fruit eatable.
Maba laurina. Green, palm-like fruit, *Kennedy.*
Gaultheria hispida. "Wax-cluster." Fruit eatable.
Gaultheriæ antipodæ var. Fruit of superior flavour, *Gunn.*
Lissanthe sapida. Fruit eatable.
Astroloma humifusa. "Tasmanian Cranberry." Fruit with a viscid apple-flavoured pulp.
Styphelia ascendens. Fruit eatable.
Leucopogon Richei, and others. Fruit eatable.
Physalis parviflora. Berries eatable.
Solanum vescum. Berries eatable and good. "Gunyang."
Solanum laciniatum. "Kangaroo-apple." A mealy, subacid fruit.
Polygonum adpressum. "Macquarrie Harbour Vine." Fruit subacid, used for tarts and preserves; leaves taste of sorrel.
Boerhaavia acuminata. Root eaten.
Leptomeria acerba, L. pungens, L. acida, and L. Billardieri. Berries eaten; native currant.
Santalum oblongatum. Fruit eaten, *Leichardt.*
Santalum persicarium. Root-bark used as food.
Santalum lanceolatum. Fruit eatable and agreeable, *Mueller.*
Fusanus acuminatus. "Quandong."
Exocarpus. Fruit of various species edible.
Atriplex Halimus. Once used as a pot-herb in New South Wales, and called "Botany Bay Greens"

Chenopodium erosum. A pot-herb. "Australian Spinach."
Rhagodia parabolica. Yields one-third its weight in salt, *Mitchell.*
Salicornia Indica. Young shoots pickled.
Ficus sp.? The "Clustered Fig." Eaten.
Morus Calcar-galli. Mulberry.
A species of *Casuarina?* is the Malleè Oak, which contains water in the cavities of the trunk.
Casuarinæ sp. Native throwing-stick made of its wood. Shoots of *C. quadrivalvis* acid.
Araucaria Bidwillii. "Bunyabunya." Seeds eaten.
Zamiæ sp. Seeds of various species eaten.
Cymbidium canaliculatum. Mucilaginous stems, etc., eaten.
Caladenia and various other Orchids have edible tubers.
Gastrodia sesamoides. Roots cooked and eaten by the Tasmanian natives.
Livistona inermis. "Palm Cabbage."
Livistona australis. "Palm Cabbage," *Leichardt.* Leaves used for baskets.
Arecæ sp. Used for baskets.
Seaforthiæ sp. Leaves used for water-baskets.
Pandanus spiralis, P. aquaticus. Mucilaginous young parts and kernels of fruit eaten.
Typha latifolia. Root an excellent food. (The pollen is made into cakes in New Zealand and Scinde.)
Caladium macrorhizon. Cultivated; root eaten.
Taccæ spp. Tubers eaten, full of starch.
Aponogeton sp. Ditto.
Dioscoreæ spp. Tubers of a wild yam eaten.
Hæmodori spp. Roots eaten.
Philydrum lanuginosum. Leaves used for women's girdles.
Flagellaria Indica. Used for cordage.
Astelia alpina. Fruit sweet, and base of leaves eaten.
Xanthorrhœæ sp. Bases of young leaves eaten raw and roasted.
Xerotes sp. Leaves used for basket-work.
Anthistiria australis. The best fodder-grass of Australia.
Panicum lævinode. Grains pounded yield excellent food.
Avena? Wild Oats. Grain excellent, *Grey.*
Oryza sativa. The Rice was found by Mueller in tropical Australia.
Pteris aquilina, var. esculenta. Root eaten raw and roasted.
Dicksonia antarctica. Pulp of top of trunk full of starch, eaten raw and roasted.
Alsophila australis. Ditto.
Agaricus campestris. Common Mushroom.
Mylitta australis. The native bread (a huge Truffle) of Tasmania.
Cyttaria Gunnii. An edible Fungus, on the branches of *Fagus Cunninghamii.*

## § 16.

### *Outlines of the Progress of Botanical Discovery in Australia.*

In the following rapid sketch of the labours of those who have mainly contributed to develop the botanical riches of Australia, I have endeavoured to give some idea of the comparative amount and value of the results of the various explorers and collectors, to indicate the extent of coast and interior wholly or partially explored, and to enumerate the narratives and other works which will be found to contain the most botanical information.

I have arranged the subject-matter under four heads.

1. Voyages of Discovery and Survey, undertaken by the English, French, and American Governments.

2. Land Expeditions undertaken by order of the Home or Colonial Governments.

3. Colonial Botanists and Botanical Gardens.

4. Botanical explorers who have worked chiefly on their own or other private resources.

In a few cases I have had to depart from this arrangement, some of the most distinguished Australian explorers having served in several capacities. Thus Allan Cunningham filled the appointments of His Majesty's Botanist in Australia, Colonial Botanist of New South Wales, Botanist to Captain King's voyages, and has also been the leader of several inland exploratory journeys. Dr. Mueller has also distinguished himself in several scientific capacities, and, for extent and range of his journeys, ranks second to Allan Cunningham alone of all Australian botanical explorers.

## I. VOYAGES OF DISCOVERY AND SURVEY.

For the first glimmerings of light upon the vegetation of Australia, we are indebted to the great buccaneer and navigator Dampier, who in 1688 visited Cygnet Bay, on the north-west coast of the Continent; and in 1699 he returned to the west and north-west coasts in H.M.S. 'Roebuck' (King's Voy., 1. xxi). The herbarium of Dampier is still preserved at Oxford, and (as I am informed by Mr. Baxter, Curator of the Oxford Botanic Gardens) contains forty specimens, eighteen of which are figured in his 'Voyage,' published in 1703.

The first botanical investigators of any part of Australia were Mr., afterwards Sir Joseph Banks, and his companion, Dr. Solander, the Naturalists of Captain Cook's first voyage. Cook's ship the 'Endeavour' anchored in April, 1770, in Botany Bay, so called by its discoverers from the number and variety of the plants collected by the naturalists during their week's stay there. Proceeding thence northward they landed successively in Bustard Bay, lat. 24° 4′, Thirsty Sound, Point Hillock, and Cape Grafton, lat. 16° 57′, beyond which point the 'Endeavour' struck on a reef, and after incurring imminent peril, she was brought to the Endeavour River, lat. 15° 26′, on the 18th June, 1770. There it was found that the herbarium had suffered from the immersion of the ship, but the greater part was eventually preserved. The 'Endeavour' subsequently visited Cape Flattery, Lizard Island, Weymouth Bay (12° 42′ S.), Possession Island, the northern extreme of Australia and Wallis's Islands.

The plants of Cook's first voyage formed part of the famous Banksian herbarium, which, after the death of its possessor, passed to the British Museum. Of the Australian plants, consisting of nearly 1,000 species, a portion only have been published in Brown's 'Prodromus Floræ Novæ-Hollandiæ.'

Captain Cook, on his second voyage, was accompanied by J. R. Forster and his son George, who made many discoveries in the Pacific islands, Fuegia, and New Zealand, but only one of his ships, the 'Adventure,' commanded by Captain Furneaux, visited any part of Australia, arriving at Adventure Bay, Tasmania, in February, 1773.

In Cook's third voyage, Adventure Bay was again visited, in January, 1777, and a considerable collection made by Mr. David Nelson, and Mr. Anderson, the surgeon of the 'Resolution,' which are preserved in the Banksian herbarium.

In 1791, Captain Vancouver's expedition, consisting of two ships, the 'Discovery' and 'Chatham,' when on their voyage to north-west America, discovered King George's Sound. The expedition was accompanied by Mr. A. Menzies, a zealous botanist, who formed a good collection at this port, some of the plants of which appear in Brown's 'Prodromus.'

In 1801, Captain Flinders's voyage, undertaken to complete the discovery of Terra Australis, was commenced: and it was continued during the two succeeding years in the 'Investigator,' 'Porpoise,' and 'Cumberland.' Owing to the late Robert Brown having accompanied this voyage, it proved, as far as botany is concerned, the most important in its results ever undertaken, and hence marks an epoch in the history of that science. Brown united a thorough knowledge of the botany of his day, with excellent powers of observation, consummate sagacity, an unerring memory, and indefatigable zeal and industry as a collector and investigator; he had further the advantage of being accompanied by a botanical draughtsman, Ferdinand Bauer, who proved no less distinguished as a microscopic observer than as an artist; and he had a gardener, Mr. Peter Good, to assist in the manual operations of collecting and preserving. Hence, when we regard the interest and novelty of the field of research, the rare combination of qualities in the botanist, and the advantages and facilities which he enjoyed, we can easily understand why the botanical results should have been so incomparably greater, not merely than those of any previous voyage, but than those of all similar voyages put together. The 'Investigator' reached King George's Sound in 1802, where Brown collected 500 species, and afterwards coasted along through Bass's Straits to Port Jackson. In July, 1802, the northern survey was commenced, and that of the Gulf of Carpentaria, where the rotten state of the ship obliged her captain to run to Timor, whence they returned by the west and south coast again to Port Jackson. The 'Investigator' was here condemned, and Captain Flinders hired another ship to sail for England, in which he took the duplicates of Brown's collections. Unfortunately this vessel was wrecked on the Cato Reef, in lat. 23° S., but the Captain, and eventually the whole crew, reached Port Jackson: the duplicate collections were of course lost. Brown and Bauer had meanwhile been left in New South Wales, where they explored the Blue Mountains; and Brown also visited the islands of Bass's Straits and Tasmania, where he resided for some months, at Risdon, on the Derwent.

Brown and Bauer finally returned to England in the 'Investigator,' arriving in 1805 with a complete set of all their collections. On his return Brown was directed by the Board of Admiralty to publish his plants, and the commencement appeared in 1810, as the 'Prodromus Floræ Novæ-Hollandiæ,' and another contribution in 1814, as the Appendix to Captain Flinders's Voyage. The first of these works, though a fragment, has for half a century maintained its reputation unimpugned, of being the greatest botanical work that has ever appeared.

Captain King's voyages come next under review, and owing to that able officer's own love of natural history, and the encouragement he consequently gave to the botanist, Allan Cunningham, who accompanied him, his surveys have been the means of adding very largely to our knowledge of the vegetation especially of tropical Australia. As however the botanical interest of his expeditions centres in Mr. Cunningham, who was even more celebrated as an inland explorer and Colonial botanist than as the companion of Captain King, I shall include a notice of the principal points touched at by Captain King in the following brief sketch of Cunningham's career.*

Allan Cunningham (born 1791) was, when a young man, engaged at Kew in the preparation of

* Extracted from the interesting biographical memoir of Allan Cunningham, by R. Heward, Esq., F.L.S., and published in the Journal of Botany, vol. iv. p. 231, and Lond. Journ. Bot. vol. i. p. 107.

Aiton's 'Hortus Kewensis,' and was thence, in 1814, despatched, through the instrumentality of Sir J. Banks and Mr. Aiton (King's Gardener at Kew), on a botanical mission to the Brazils, and thence, in 1816, to New South Wales. In 1817 he accompanied Lieutenant Oxley's* expedition to explore the Lachlan and Macquarrie rivers. This journey, a toilsome and painful one of 1,200 miles, extended across the Blue Mountains, within the parallels of 34° 30′ and 32° S. lat., and 149° 43′ and 143° 40′ E. long., and produced about 450 species of plants.

After his return to Sydney, Mr. Cunningham was engaged as botanist to Captain King's surveying voyage, and arrived in the 'Mermaid' at King George's Sound, early in 1818: here traces of Vancouver's garden were searched for in vain. Thence they proceeded to the islands and west coast near Dampier's Archipelago, the Goulburn islands, and visited Timor before returning to Port Jackson. This voyage seems to have yielded very few novelties, for in a letter to Mr. Heward he says that the aggregate of his collections made on the coasts of Australia, does not exceed 300 species.

Subsequently Mr. Cunningham visited the Illawarra district, perhaps the richest botanical province in Australia, and in 1818 accompanied Captain King to Hobarton and Macquarrie Harbour.

The survey of the north and west coasts was commenced by King in the 'Mermaid,' in May, when Port Macquarrie and the Hastings River were visited, and the following places were successively touched at,—Rodd's Bay, Percy Isles, Cleveland Bay, Halifax and Rockingham Bays, the Endeavour River: after passing through Torres Straits, they stood across the Gulf of Carpentaria to Liverpool River and Goulburn Islands for the second time, Vernon Islands, Cambridge Gulf, and Port Warrender, whence they again visited Timor before returning to Port Jackson.

The third voyage of the 'Mermaid' was undertaken in June, 1819, when Cunningham visited Port Bowen, the Endeavour River, Lizard Island, Cape Flinders, Pelican, Haggerston, and Cairncross Islands, Goulburn and Sim's Islands, Montague and York Sounds, Port Nelson, Brunswick Bay, and returned to Port Jackson in December.

In 1821, the survey was continued, when Cunningham visited Percy Islands, Cape Grafton, Lizard Island, Cape Flinders, Clark's Island, and for the third time, Goulburn and Sim's Islands, Careening Bay, Prince Regent's River, and Hanover Bay, whence they proceeded to the Mauritius to refit. Thence they sailed to King George's Sound, where Cunningham found no traces of his own garden, formed (in 1818) with great labour. Thence they proceeded up the west coast to Dirk Hartog's Islands and Cygnet Cove, whence they sailed for Port Jackson, where terminated Cunningham's connection with the coast survey.

In 1822, Cunningham again visited Illawarra, and afterwards crossed the Blue Mountains, to the water-heads of the Macquarie. On his return to Sydney in January, 1823, he prepared for a more extended expedition, in which he opened up some of the most fertile districts of New South Wales. Starting from Bathurst he proceeded to the Liverpool Plains, to which he descended from the Pandora's Pass, discovered by himself, on the Blue Mountains, and visited the valleys beyond Hawksbury Vale.† In November, 1823, he again left Sydney to explore another pass that had been discovered leading to the Hawksbury.

In 1824, Cunningham visited the southern parts of the Colony, by Camden, Argyll, Lakes George and Bathurst, the source of the Murrumbidgee, Brisbane Downs, and Shoalhaven Gullies.

* See Journals of Two Expeditions into the Interior of New South Wales, by John Oxley, Lieut. R.N. 4to, 1820.

† An Account of this journey will be found in Field's 'New South Wales,' p. 133.

In the autumn of the same year he visited Illawarra for the third time, and still later in the year he explored the Brisbane River with Lieutenant Oxley.

In 1825 another expedition to the north-west was undertaken by Cunningham. Crossing the Nepean he proceeded to the southern feeders of the Hunter, and thence to the Pandora's Pass, descended to the Liverpool Plains, and ascended the Camden Valley to lat. 30° 47′ S., long. 150° E. The three last months of the same year were spent in examining Wellington Valley, and the six following at Cox's River and the Illawarra district.

In 1826, Cunningham visited New Zealand. Returning in January, 1827, he undertook the command of another most arduous expedition, in which he skirted the Liverpool Plains, crossed the Peel and Dumaresq Rivers, and discovered Darling Downs, in lat. 28° S., Cumming's Downs, and Peel's Plains, and after making various detours, returned to the Hunter's River, and thence by a new route to Paramatta and Sydney.

In 1827 and 1828, Cunningham was collecting at Bathurst and Illawarra. In June 1828, he again visited Moreton Bay * with Mr. Fraser the colonial botanist, made an expedition to Mount Lindsay, to the Limestone station in Bremer River, discovered another pass across the mountains, proceeded north-west to Hay's Peak and Lister's Peak, and returned to Brisbane and Sydney.

In 1829, Cunningham again explored the Blue Mountains, and in May of the same year took a third voyage to Moreton Bay, visited the head-waters of the Bremer and Campbell's Range, Norfolk Island, and Phillip Island, and returned to Sydney. In December he visited Illawarra and Broken Bay.

In January, 1831, Cunningham crossed the Blue Mountains to Cox's River, and in February he sailed for England, where he took up his residence at Kew. In 1832, owing to the death of Charles Fraser, the situation of Colonial Botanist in New South Wales fell vacant; it was offered to Cunningham, but he declined in favour of his brother Richard, who reached Sydney in 1833, and was murdered in Mitchell's journey in 1835. The appointment was thereafter again offered to Allan Cunningham, and being accepted, he sailed for Port Jackson in 1836. The duties expected from the Colonial Botanist were however, at that time, neither scientific nor such as any one having the good of the colony at heart could conscientiously perform, and Cunningham soon resigned the appointment.

In 1838, Cunningham again visited New Zealand, and returned in the same year to Sydney. His labours were now rapidly drawing to a close; his originally robust and long severely tried constitution having been gradually undermined during twenty-two years' incessant travelling, was now found to have been so irremediably shattered in New Zealand, that he was in 1839 reluctantly compelled to decline accompanying Captain Wickham in his survey of the north-west coast; soon after which he died, in the Botanic Garden, Sydney, in June 1839, at the early age of forty-eight.

I have dwelt at length upon Allan Cunningham's botanical travels, because they are by far the most continuous and extensive that have ever been performed in Australia, or perhaps in any other country. His vast collections were, for the most part, transmitted to Kew, whence they were transferred to the British Museum. A very complete set was however given to Sir W. Hooker, and his own private herbarium was left to his early and attached friend *R. Heward, Esq., F.L.S.*, from whose memoir most of the above information is abridged.

Cunningham's most important published works consist of an Appendix to 'King's Voyage,' and the 'Prodromus Floræ Novæ-Zelandiæ,' published in the 'Companion to the Botanical Magazine' and the 'Annals of Natural History.' He also wrote 'A Specimen of the Indigenous Botany of the

* I find in Sturt's Australia (vol. i. p. 154) that an account of this journey was published in Sydney.

'Blue Mountains,' the result of observations made in October, November, and December, 1822, prepared in 1823, and published (1825) in Field's 'Australia,' p. 323; and a 'Journal of a Route from Bathurst to Liverpool Plains in 1823,' *ibid*, p. 131.

Captain King was succeeded by Captain Wickham, who in 1837 commissioned H.M.S. 'Beagle' to explore certain parts of north-western Australia, and the best channels through Bass' and Torres' Straits. Owing to Captain Wickham's illness the command devolved on Captain J. Lort Stokes, who drew up the narrative of the voyage. No botanist accompanied the Expedition, nor is there in the narrative any information of importance on the vegetation of the coasts surveyed; but Mr. Bynoe, the surgeon, made some valuable collections, chiefly on Dupuch Island, the Abrolhos, the Victoria River, Bass' Straits, and in New South Wales, which are preserved in Sir W. Hooker's herbarium. The 'Beagle' returned to England in 1843.

The establishment of Port Essington was founded in the year 1838, by Sir Gordon Bremer. Mr. M'Gillivray was stationed at it for some time during the Expedition of Captain Blackwood; and Mr. Armstrong, a collector sent by Kew Gardens, resided there for several years, and made important collections, a considerable portion of which are in Sir W. Hooker's herbarium.

In 1840, Captain Sir James Ross visited Hobarton in H.M.SS. 'Erebus' and 'Terror,' and spent the months of August, September, and October there, during which extensive collections were made by Dr. Lyall and myself, in the Derwent, and in the Lake district of Tasmania, and at Port Arthur.

In 1841, the same Expedition returned to Hobarton to refit, and stayed through March, April, and May, when the botanist visited the Huon River and Richmond districts. From Tasmania the Expedition proceeded to Port Jackson, where also a considerable herbarium was formed, chiefly in the neighbourhood of Sydney and Botany Bay.

In 1842, Captain Blackwood was sent out in H.M.SS. 'Fly' and 'Bramble,' to make a further survey of the tropical coasts of Australia, in which voyage he was accompanied by Mr. M'Gillivray as Naturalist. The narrative of the Expedition was written by Mr. Jukes (Geologist to the Expedition), and contains no botanical matter. The coasts and islands visited by the 'Fly' and 'Bramble' had been previously explored by Cunningham, and subsequently by Mr. M'Gillivray, a skilful naturalist, in H.M.S. 'Rattlesnake,' whose collections were sent to Sir W. Hooker.

In 1847, H.M.S. 'Rattlesnake' was fitted out by Captain Owen Stanley, to discover openings through the Barrier Reefs in Torres' Straits, to the northward of Raine Island passage, to examine Harvey Bay as a site for a new settlement, and to make a general survey of the Louisiade Archipelago.

Many places were visited between Sydney, Cape York, and Port Essington, and excellent collections made at Port Curtis, Rockingham Bay, Port Molle, Cape York, Goold, Lizard, and Moreton Islands. The Expedition was accompanied by Mr. M'Gillivray, upon whom the task of editing the narrative of the voyage devolved, owing to the death of its commander, in Sydney. Mr. M'Gillivray's narrative abounds in interesting observations on the vegetation of Australia. Among the most noticeable discoveries are, that of a clump of Cocoa-nuts on Frankland Islands, whence, no doubt, the nuts and husks were washed to the mainland, where they had excited the curiosity of Cook, King, etc.; of *Caryota urens* and a native *Musa*, on the Peninsula of Cape York, and of the *Balanophora fungosa* in Rockingham Bay. The author also mentions the existence of the Pomegranate on Fitzroy Island, where (if no error exists) it has no doubt been planted.

The account of Mr. Kennedy's disastrous attempt to penetrate from Rockingham Bay to Port Curtis is appended to Mr. M'Gillivray's work; it terminated in the murder of its leader, and death, by starvation, of most of his party. Amongst the survivors was Mr. Carron, the botanist, whose narrative is full of excellent observations on the vegetation of the swampy and almost impracticable country traversed. It includes the notice of a *Nepenthes*, which, with the rest of the collection, was lost. Mr. M'Gillivray's herbarium was given to Sir W. Hooker, and contains several hundred species in excellent preservation.

The only other English naval expedition remaining to be noticed is that of Captain Denhâm, now surveying the Pacific Islands in H.M.S. 'Herald.' He was accompanied by Mr. M'Gillivray and a botanical collector: and has sent some interesting collections from Lord Howe's Island, between Australia and New Zealand, and from Dirk Hartog's Island and Sharks Bay.

The French Expeditions rank next in importance to the British. Of these the first is that of D'Entrecasteaux. In 1792 the French Expedition, under General D'Entrecasteaux, visited Tasmania and south-western Australia. Considerable collections were made by M. J. J. Labillardière, who published figures and descriptions of 265 of the most interesting in his 'Novæ-Hollandiæ Plantarum Specimen,' 2 vols. 4to, Paris, 1804, and described a few others in the narrative of the voyage, which was written by himself, a work accompanied by folio plates of several of the plants.

In 1800, the Expedition of Captain Baudin, in the 'Géographie,' 'Naturaliste,' and 'Casuarina,' left France on a voyage of discovery and survey along the shores of Australia. Out of a large staff of naturalists, MM. Leschenault de la Tour, the botanist,* and Riedlé, Sautier, and Guichenot, all gardeners, seem to have been chiefly occupied with the botanical department, and formed large collections, which are now in the Jardin des Plantes. They were collected principally on the islands of the north-west and west coasts, in Tasmania and New South Wales. These were not published in a connected manner, but they gave rise to various papers, in the 'Mémoires du Muséum' and 'Annales du Muséum,' by Desfontaines and others.

Some general remarks on the botany of Australia and Tasmania are given by M. Leschenault in the second volume of the Narrative of the Expedition (4to, Paris, 1816); and many of the plants figured in the fine work of M. Ventenat, 'Jardin Malmaison,' were introduced into Europe by the officers of this voyage.

In 1818 and 1819, Captain Freycinet's Expedition in the French corvettes 'Uranie' and 'Physicienne' visited the Baie des Chiens Marins on the west coast of Australia, where considerable collections were made by M. Gaudichaud, and afterwards, at various parts of New South Wales, Port Jackson, Botany Bay, the Blue Mountains, etc. A few of the plants were published by the same naturalist and others,† in a quarto volume of letterpress and folio of plates (Paris, 1826).

In 1824, Captain Duperrey visited Sydney in the corvette 'La Coquille,' on a voyage of discovery. She carried two naturalists, M. D'Urville (afterwards the celebrated Admiral, and an ardent botanical collector), and Lesson, an accomplished zoologist. A portion of the plants of this voyage were published in 1829, by MM. Brongniart, D'Urville, and Bory de St. Vincent, in a series of 78 folio plates, and a quarto volume of 232 pages; both parts are however incomplete.

In 1827 the French discovery-ship 'L'Astrolabe,' commanded by Captain D'Urville, visited Port Jackson; she was accompanied by M. Lesson, as naturalist. Some botanical collections were made, but more important ones were received from Mr. Fraser, Superintendent of the Sydney Botanic

* Two other botanists, A. Michaux (afterwards author of the 'Sylva Americana'), and J. Delisse, also embarked on this expedition, but left it at the Isle of France, on the outward voyage. Bory de St. Vincent, afterwards eminent as a botanist, embarked as zoologist, and was also left at the Isle of France.

† The Lichens and Fungi by Persoon, *Algæ* by Agardh, Mosses and *Hepaticæ* by Schwægrichen.

Gardens. Of these a few were published by Lesson and A. Richard, in 1832, in an octavo volume of letterpress, and folio of plates.

Captain D'Urville again visited Australia, Sydney, and also Tasmania, when on his memorable voyage to the Antarctic regions in 1839, when collections were made by MM. Hombron and Jacquinot, the medical officers of the Expedition, at Sydney, Port Essington, Raffles Bay, etc., but very few of them have been published.

The United States Exploring Expedition, under Commodore Wilkes, visited Tasmania and Sydney in 1839, and large collections were made, near Port Jackson, etc. These have been in part published by Professor Asa Gray, of Harvard University, Cambridge, in his excellent 'Botany of the United States Exploring Expedition,' of which one quarto volume of letterpress and one folio volume of plates alone have hitherto appeared.

The Austrian exploring-frigate 'Novara' has returned to Europe during the passage of these sheets through the press, and has no doubt brought valuable collections, but I am not aware of their nature or extent.

### II. LAND EXPEDITIONS UNDERTAKEN BY ORDER OF THE HOME OR COLONIAL GOVERNMENTS.

The first Colonial Expeditions that added much to our knowledge of the botany of Australia were those of Lieutenant Oxley, Surveyor-General of New South Wales, across the Blue Mountains. Mr. Oxley started on his first expedition, in 1817, to ascertain the course of the Lachlan, and was accompanied by Allan Cunningham, as King's Botanist, and Mr. Fraser, as Colonial Botanist. Early in 1818, Mr. Oxley, with Mr. Fraser, again left Sydney, to examine the course of the Macquarie. On both these occasions large collections were made, and the journal of the Expedition was published by Lieutenant Oxley in one quarto volume (London, 1820).

The land expeditions of Allan Cunningham, in 1826 and 1827, are the next in date; they have been already noticed (at p. cxiv.). Captain Sturt's Expedition was despatched to follow up Cunningham's and Oxley's discoveries.

Captain Charles Sturt, an officer of his Majesty's 39th Regiment, then on military duty in New South Wales, was commissioned by the Colonial Government to ascertain the course of the rivers rising on the western watershed of the Blue Mountains. He accordingly left Sydney in 1828, proceeded to the Wellington Valley, then the most remote north-western settlement, and proceeded down the Macquarie to the Darling River, whence he returned to Sydney. In 1829 another Expedition was fitted out, under Captain Sturt, and despatched to the Murrumbidgee River, when the Murray was discovered, and named, and followed to its debouche in Lake Alexandria, and thus into the sea, from whence the Expedition returned by the same rivers. There are no botanical observations in the narrative of these remarkable and interesting journeys, nor is there any notice of collections having been made.

In 1844, Captain Sturt started from Adelaide on another and still more remarkable journey, when, advancing north into the heart of Australia, he reached the 25th parallel of latitude in longitude 139 E. On this occasion a considerable collection was made, amounting to about 100 species, some of which were described by Brown in the appendix to Captain Sturt's narrative of the Expedition.

Captain (now Sir George) Grey's Expeditions on the west coast of Australia were organized in the hope of discovering a large river or inlet which was supposed to exist in that quarter. The party arrived in Hanover Bay (lat. 15° S.) in 1837, whence several inland journeys were made to the south-west, and the Glenelg River discovered.

Captain Grey's second expedition was made in whale-boats, which he took with him in a sailing-vessel from Swan River. He first landed on Bernier Island (lat. 25° S.), where he made a depôt; thence he crossed to the Gascoyne River, and explored the coasts for some miles to the northward, and after encountering great difficulties and hardships, he returned to Bernier Island, where he found that the stores had been utterly destroyed by the ocean, which during the stormy interval had swept over the island. This obliged Captain Grey to return to the mainland, which he reached at Gantheaume Bay (lat. 27° 50′ S.). Here the boats were abandoned, and the overland journey to Swan River commenced, which was reached by a remnant of the party after having suffered incredible hardships from starvation and the natural difficulties of the country. Of course no collections of plants were brought back, but the commander's narrative abounds in valuable observations on the vegetation of the countries visited. Amongst many other observations worthy of note, are that of an *Araucaria* occurring on the mountains of the interior, of a Swan River *Banksia* near Prince Regent's River, of *Xanthorrhœa* attaining the latitude of 28°, and *Zamia* of 29°, in which latitude the common Sowthistle appears to have been found abundantly. Many notices of edible plants are scattered through the narrative, including that of a 'Wild Oat,' with large grains, which Captain Grey states has been cultivated with success as a cereal in the island of Mauritius.

Major Mitchell's extensive journeys come next under review, aud owing to his great fondness for natural history, and excellent system of observation, his writings and his collections have both proved eminently useful in advancing our knowledge of Australian botany.

Mitchell's first Expedition originated in a report of the existence of a large river in central Australia, called the Kindur, in search of which he started in November, 1831. His party proceeded northward from Sydney, crossed the rivers Hawkesbury and Hunter, and then the watershed in lat. 32° S., long. 151° E.; thence they traversed Liverpool Plains, and traced the Gwydyr to lat. 29° S., returning to Sydney in March. The collections were divided between Mr. Brown and Dr. Lindley.

The second Expedition was organized in 1835, to explore the course of the Darling River. On this journey the Boga? River was followed from its sources to its junction with the Darling in lat. 30° S., long. 146° E., and the latter river, thence traced in a south-western direction to lat. 32° 30′ and long. 142° 30′. Richard Cunningham, the brother of Allan, who was then Colonial Botanist, accompanied Major Mitchell, and was murdered by the Blacks. The plants were given to Dr. Lindley, by whom many have been described in notes to the 'Journal of the Expedition.' The *Trigonella suavissima* was found on this journey, and copiously used as an excellent Spinach.

Mitchell's third Expedition left Sydney in 1836, with the object of following the Darling from the point where he had left it to its confluence with the Murray. This plan was however modified, and the Lachlan river was followed instead to its junction with the Murrumbidgee, and the latter to its confluence with the Murray, which was traced to the Darling in lat. 34° S. and long. 142° E.: thence the party returned to the Murrumbidgee, and proceeded in a south-western direction to the mountains of Victoria. There Mount William (alt. 4,500 feet) was ascended, and many plants found and observations made on the peculiarity of the alpine vegetation. In July the party reached the Glenelg River, and followed it to the sea at Discovery Bay, in Bass' Straits, which they reached in August. The return journey was made through the heart of the Victoria alps, crossing the Bagungum, Murray, and Murrumbidgee rivers high up in their course, and reaching Goulburn in New South Wales in the following November. In this very extraordinary journey Mitchell was accompanied by a good plant-collector named Richardson, and the collections were brought safe and in good condition to Sydney, and sent to Dr. Lindley, by whom many have been described.

The narratives of the three journeys were published in two volumes, 8vo; they abound in useful and instructive information to the geographer, and especially to the naturalist. Dr. Lindley's descriptions are appended as notes to the pages of the volume, and render it a most important work to the botanist.

Mitchell's fourth Expedition was to subtropical Australia, and was undertaken in the hope of discovering a river flowing into the Gulf of Carpentaria, which would take much of the Australian produce to the sea without passing through Torres Straits. Very fine collections were made in this journey, chiefly amongst a group of mountains 2–3,000 feet high, discovered in lat. 25° S. and long. 147° E. The plants were given to Dr. Lindley and Sir W. Hooker, by whom descriptions were drawn up and appended to the narrative of the journey, which was published in 1848.* Like Mitchell's other works, this contains excellent landscapes from sketches made by himself, which give faithful as well as artistically good views of the vegetation he describes, and render his works as attractive as they are useful to the naturalist.

In 1844 the lamented Dr. Ludwig Leichardt, after spending several years in New South Wales, started on his adventurous journey from Moreton Bay to Port Essington. This Expedition originated in private enterprise, but it was promoted by a public subscription in the colony, and I have hence classed it amongst the Colonial enterprises. Starting from Moreton Bay, he proceeded north-west to the Gulf of Carpentaria, coasted its head, and travelled northwards through Arnheim's Land to Port Essington, which he reached after a journey of a year and two months.

The narrative of Dr. Leichardt, who appears to have had a very considerable knowledge of botany, contains as much Botany as Geography, and is by far the fullest published detailed account of the tropical vegetation of the interior of Australia that we possess.

In December 1846, Dr. Leichardt started from Sydney with the view of crossing Australia from Moreton Bay to Swan River, a journey which he calculated would occupy two years and a half. Since his departure, however, from a point on his previous journey, a little to the north-west of Moreton Bay, nothing has been heard of this accomplished man and adventurous explorer.

Dr. Leichardt's collections became, I believe, the property of his friend the late Mr. Lind, barrack-master in Sydney, and were eventually sold.†

In 1840, Captain Eyre's perilous journey from Adelaide to the Swan River proved the utter sterility of the waterless coast which he traversed. Between the meridians of Streaky Bay and Lucky Bay there appears to be scarcely any vegetation at all, except on the outlying islands, on some of which Brown had botanized when in Flinders' voyage, and on which he appears to have found very little. At the meridian of 118° again the peculiar vegetation of south-western Australia commences, as we know from Mr. Roe's explorations, which next come under review.

In 1848 a journey of discovery into the interior of south-western Australia was undertaken by J. S. Roe, Esq., Surveyor-General, during which excellent collections of plants were made and trans-

* An abstract of this journey was also communicated to the 'London Journal of Botany' (vol. vi. p. 364) by R. Heward, Esq.

† Some further information regarding Dr. Leichardt's expeditions will be found in the 'London Journal of Botany,' vols. iv., v., vi., and vii., communicated by P. B. Webb, Esq., and R. Heward, Esq.

mitted to Sir W. Hooker. Mr. Roe started from Cape Riche, and proceeded north-east to the Bremer Range, lat. 32° 35′ S., long. 120° 30′ E., and then south-east to Russell Range, whence he returned parallel to the south coast. The narrative of this journey, which contains much botanical information, was published in the 'Kew Journal of Botany,' vol. vi.

Dr. Ferdinand Mueller's extensive journeys and important labours come next under review. They extend already over a period of ten years of uninterrupted exertion in travelling, or collecting and describing, often under circumstances of great hardship and difficulty, and are of very great merit and importance.

Dr. Mueller first resided at Adelaide,* whence he removed to Melbourne, and was appointed Colonial Botanist at Victoria. In 1853 he visited the Fuller's Range, Mayday Hills, the Buffalo Ranges, Mounts Aberdeen and Buller, and the Yarra Ranges, whence he descended to the coasts of Gipps Land, and returned to Melbourne by Port Albert and Wilson's Promontory. In this journey he traversed 1,500 miles, and collected nearly 1,000 species of plants. This journey is noticed in his 'First General Report,' which contains a Catalogue of the Flowering Plants and Ferns of Victoria.

In 1854, Dr. Mueller visited more of the mountains of the colony, and explored many of the most difficult regions of South Australia; he also visited Lake Albert, the Murray Lagoons, the Cobboras Mountains, the Snowy and Buchan rivers, and the Grampian and Victoria ranges. During this expedition about 2,500 miles were traversed, and upwards of 500 additional plants collected. These are enumerated in Dr. Mueller's 'Second Report,' in which the catalogue of Victoria plants is raised to 1,500 species.

In 1854–5, Dr. Mueller again visited the Australian alps, traversed the Avon Ranges, ascended Mount Wellington, crossed the Snowy Plains, reached the Bogong Range, and measured Mounts Hotham and Latrobe (7,000 feet), the loftiest in the Australian continent. Thence he proceeded to the Munyang Mountains, and afterwards to the south-east coast, when he returned to Victoria. The account of this journey is published in Dr. Mueller's 'Third Report,' wherein the Victoria Flora is raised to 2,500 species, including *Cryptogamiæ*, 1,700 being flowering plants.

In the intervals between these journeys Dr. Mueller has been incessantly employed in the duties of the Botanic Garden, in arranging and distributing his herbaria, and in publishing their novelties.

In 1855, Dr. Mueller accompanied Mr. Gregory in his celebrated expedition across northern Australia. Mr. Gregory's party left Sydney in a schooner, carrying their horses and all material with them. On the voyage out, Dr. Mueller collected on several islands off the east and north coasts of Australia, and landed with the party at the mouth of the Victoria River, in north-western Australia, in September. The river was ascended, and the country to the south explored to the limits of the Great Desert in lat. 18° 20′ S., long. 127° 30′ E. From the Victoria River they traversed Arnheim's Land, and keeping within a hundred miles of the sea, reached the mouth of the Albert, in the Gulf of Carpentaria, on the 30th August. Not meeting there with the expected supplies, Mr. Gregory and his party proceeded eastward, parallel to the coast, to the Gilbert River; thence they travelled south-east, crossed the head of the Lynd, reached the Burdekin, followed it to the Suttor, and the Suttor to the Beylando, the Mackenzie, and the Dawson rivers, where they reached the first settlers' station on the 22nd November, and from thence proceeded to Brisbane and Sydney, which was reached without the loss of a member of the overland Expedition.

* A sketch of the vegetation of a part of this colony, viz. of the districts surrounding Lake Torrens, by Dr. Mueller, will be found in the 'Kew Journal of Botany,' vol. v. p. 105.

This extraordinary journey is second in point of interest and extent of unknown country traversed to Leichardt's only, and, unlike his, is no less fruitful of results in a botanical than in a geographical point of view. The energies of Dr. Mueller were here taxed to the uttermost; and the collections and botanical observations which were continuously and systematically made throughout the journey were brought safe to Sydney, and abound in novelty and interest. These have been sent to Kew, and a set retained for the herbarium at Melbourne. An excellent account of the vegetation of tropical Australia was drawn up by Dr. Mueller,* and communicated to the Linnæan Society, and published in its Journal (vol. ii. p. 137), and many of the plants discovered have been published by himself in that work, in the 'Kew Journal of Botany,' and in the 'Transactions of the Victoria Institute.'

It would be beyond the object of this sketch to enter into more detail upon Dr. Mueller's publications, which will be found in his 'Reports' alluded to, in the pages of the Transactions of the Philosophical Society and Pharmaceutical Societies of Victoria, in the 'Linnæa,' in the 'Kew Journal of Botany,' and in the 'Journal of the Linnæan Society of London.'

Mr. Babbage's expedition to the countries around and north-east of Lake Torrens was undertaken in 1858. Mr. Babbage was accompanied by a plant-collector, Mr. David Hergolt, who seems to have made a good herbarium, especially considering the desert nature of the country. The results are published in a separate Report on the Botany of the Expedition, by Dr. Mueller (Victoria, 1859).

In 1858, an Expedition under Mr. A. C. Gregory was despatched from Moreton Bay to discover traces of the unfortunate Dr. Leichardt, when collections were made by that officer along and near the Cooper's River and its tributaries in subcentral Australia, which have been enumerated by Dr. Mueller in the official Report.

### III. COLONIAL BOTANISTS AND GARDENS.

The first Colonial Botanist of whom I have any information was Mr. Charles Fraser, who, as I am informed, was a soldier in the 73rd Regiment, then commanded by Lieut.-Col. M'Quarie. He was an indefatigable collector and explorer, and enriched the gardens of England by numberless plants. His collections of dried plants are, I believe, in the British Museum, and many are in the Hookerian Herbarium. He visited the Swan River in 1826–7, and Moreton Bay in 1828, and wrote excellent accounts of the vegetation of those districts (see Hook. Bot. Misc. vol. i. pp. 221 and 237). Mr. Fraser also visited Tasmania, and established the Botanic Garden in Sydney. He died at the close of 1831 or beginning of 1832. On Fraser's death, Mr. John M'Lean became Acting Superintendent, and held that post till the arrival of R. Cunningham.

Mr. Richard Cunningham was appointed in 1833, and was murdered in 1835 by the Blacks, when accompanying Major Mitchell's second journey (see p. cxx.), when Mr. M'Lean again became Acting Superintendent, and continued so till the arrival of Allan Cunningham in 1836, as mentioned in the notice of his life (p. cxvi.). A. Cunningham soon after resigned, when he was succeeded by Mr. John Anderson, the botanical collector of Captain King's voyage to South America and survey of the Straits of Magelhaens, etc. It was on King's homeward voyage that Anderson was left at Sydney, where he made considerable collections, and held the appointment of Superintendent of the Garden till his death, when he was succeeded, in 1847, by Mr. Charles Moore, the present active

* See page xxxix of this Essay.

Superintendent, who has made extensive investigations, especially on the economic value of the vegetable products of New South Wales.

Of the actual date of the foundation of the Sydney Botanical Gardens I have no information. Mr. Heward, who has kindly endeavoured to trace its history for me in the records of the Colonial Office, finds the earliest official mention there, bearing date of 1817, but he thinks it was probably founded shortly after Governor M'Quarie's arrival, in 1809. There are three other botanical gardens in Australia; that of Victoria, at Melbourne, under the direction of the indefatigable Dr. Mueller; that of Adelaide, under Mr. Francis; and that of Brisbane, superintended by Mr. W. Hill, who has already made some interesting and important discoveries in the Flora of his district.

### IV. PRIVATE TRAVELLERS, AND COLLECTORS SENT OUT BY HORTICULTURAL ESTABLISHMENTS OR BY PRIVATE INDIVIDUALS.

In 1788, Mr. John White landed in Botany Bay, where, or at Sydney, he was resident for seven years as Surgeon-General to the new settlement. He collected a considerable number of plants, and made drawings of others, which were sent to Mr. Wilson, Mr. Lambert, and Sir James Smith, and published by the latter botanist in 'A Specimen of the Botany of New Holland,' the 'Exotic Botany,' etc., in White's 'Journal of a Voyage to New South Wales,' and other works.

About 1800, Mr. George Caley was sent to New South Wales by Sir Joseph Banks, and botanized there during the time of Brown's stay. According to Captain Sturt, he was the first person who attempted to scale the Blue Mountains. He resided ten years in the colony, and made extensive collections, which are preserved in the British Museum. After his return to England, he was sent to the West Indies as Superintendent of the Botanic Garden of St. Vincent's, where he died.

Colonel Paterson held a military appointment in New South Wales previous to 1794, when the command of the troops in the colony devolved upon him as Captain of the New South Wales Corps (afterwards 102nd Foot). He zealously devoted himself to investigating the botany of the colony, and also of the northern parts of Tasmania, where he was Lieutenant-Governor from 1804 till 1810 during which time he founded Launceston. His plants were sent to Sir J. Banks and Mr. Brown, and some are published in the Supplement to the 'Prodromus' and elsewhere.

I have already alluded to Mr. Peter Good, who accompanied Mr. Brown in the capacity of gardener in Flinders's voyage. He was an indefatigable assistant as collector of plants, and sent a vast number of seeds home to the Royal Gardens of Kew, the plants of which are described in Aiton's 'Hortus Kewensis.'

Mr. David Burton botanized in New South Wales in 1802, but under what circumstances I have no means of determining.

In 1823–5 and 1829, the vicinity of King George's Sound, Wilson's Promontory, Cape Arid, and Lucky Bay were explored botanically by Mr. Baxter, a gardener sent out by private enterprise to collect seeds and roots of Australian plants. Many of his specimens are in Sir W. Hooker's collections, and others in Mr. Brown's, the *Proteaceæ* of which are included in the Supplement to the 'Prodromus Floræ Novæ-Hollandiæ.'

In 1823, Franz Wilhelm Sieber, of Prague, a botanical collector, formed considerable collections during a seven months' sojourn in New South Wales, which were sold in numbered sets, bearing the label, "Flor. Nov. Holl."

In 1826, Mr. Robert William Lawrence, a settler in Tasmania, commenced exploring the northern parts of that island, and forming collections, which were communicated to Sir W. Hooker up till 1832, when he died. Some of these plants were published in the 'Companion to the Botanical Magazine,' 'Journal of Botany,' 'Icones Plantarum,' and elsewhere.

In 1830, Mr. John Lhotsky visited New South Wales, the alps of Victoria and Tasmania. His collections are dispersed.

Ronald Campbell Gunn, Esq., F.R.S. and L.S., to whose labours the Tasmanian Flora is so largely indebted, was the friend and companion of the late Mr. Lawrence, from whom he imbibed his love of botany. Between 1832 and 1850, Mr. Gunn collected indefatigably over a great portion of Tasmania, but especially at Circular Head, Emu Bay, Rocky Cape, the Asbestos and Hampshire Hills, Western Mountains, Flinders and other islands in Bass' Straits, the east coast, the whole valley of the Derwent, from its sources to Recherche Bay, the lake districts of St. Clair, Echo, Arthur's Lakes, and the country westward of them to Macquarie Harbour, and the Franklin and Huon rivers. There are few Tasmanian plants that Mr. Gunn has not seen alive, noted their habits in a living state, and collected large suites of specimens with singular tact and judgment. These have all been transmitted to England in perfect preservation, and are accompanied with notes that display remarkable powers of observation, and a facility for seizing important characters in the physiognomy of plants, such as few experienced botanists possess.

I had the pleasure of making Mr. Gunn's acquaintance at Hobarton, in 1840, and am indebted to him for nearly all I know of the vegetation of the districts I then visited; for we either studied together in the field or in his library; or when he could not accompany me himself, he directed one of his servants, who was an experienced guide and plant-collector, to accompany me and take charge of my specimens. I can recall no happier weeks of my various wanderings over the globe, than those spent with Mr. Gunn, collecting in the Tasmanian mountains and forests, or studying our plants in his library, with the works of our predecessors Labillardière and Brown.

Mr. Gunn made a short visit to Port Phillip and Wilson's Promontory, and collected largely, noting all the differences between the vegetation of the opposite shores of Bass' Straits.

Mr. Collie, one of the naturalists in Captain Beechey's voyage to the west coast of North America, visited South-western Australia about the year 1832, and made collections in Swan River and Leuwin's Land.

Mr. James Backhouse visited Australia in 1832, and spent six years there. The journey was undertaken, as his narrative informs us, "solely for the purpose of discharging a religious duty," but owing to his knowledge of botany, his connection with a fine horticultural establishment (the Nursery, York), and his love of observing and collecting, the results of his journey have proved extremely valuable in a scientific point of view, and added much to our familiarity with Australian vegetation.

Mr. Backhouse first landed at Hobarton, and then, and on two future occasions, visited numerous parts of Tasmania, on the Derwent and Clyde, Macquarie Harbour, Port Arthur, Spring Bay, various stations on the north coast, and the mountainous interior; he also twice visited New South Wales, and made excursions to the Blue Mountains, Bathurst, Moreton Bay, Newcastle, Maitland, Port Macquarie, Illawarra, and Goulburn; and afterwards went to Port Phillip, Adelaide, King George's Sound, and Swan River. The journals of these various extensive journeys are extremely good, and though specially devoted to philanthropic objects, they omit no observations on natural history, and especially of botany, that their talented author considered might be worthy of such a record. Mr.

Backhouse formed a considerable herbarium, and made copious MS. notes (now in the Hookerian Library), which he liberally gave where he thought they would be most useful. Amongst his plants are many collected by Mr. (now Sir William) M'Arthur, one of the most accomplished and zealous patrons of science in Australia.

Baron Charles von Hügel, the celebrated Austrian traveller, visited the Swan River colony in 1833, and made considerable collections, some of which were published by Bentham, Fenzl, Schott, and Endlicher, in a work edited by the latter, and commenced in 1837, but never completed.

In 1838, Dr. Ludwig Preiss arrived at Swan River, and resided there for four years, travelling often with Mr. Drummond, and collecting largely. His plants were sold in numbered sets, and a complete account of them, published by various authors, in two octavo volumes, edited by Dr. Lehmann of Hamburg, and containing upwards of 2,000 species, including *Cryptogamiæ.*

Early in 1839, Mr. James Drummond, a resident in the Swan River, at Hawthornden, near Guildford, commenced preparing for sale in Europe sets of the plants of his district, which include a vast number of novelties, and rival in interest and importance those of any other part of the world. Mr. Drummond's exertions were actively continued for upwards of fifteen years, during which he made extensive journeys as far as King George's Sound in a south-east direction, and the Moore and Murchison rivers to the northward. Some accounts of his journeys and discoveries will be found in the 'Botanical Journal,' vols. ii., iii., and iv., in the 'London Journal of Botany,' vols. i., ii., and iii., and in the 'Kew Journal of Botany,' vols. i., ii., iv., v.

Dr. Lindley's able 'Sketch of the Vegetation of the Swan River Colony,' published in 1839, as an appendix to the 'Botanical Register,' is founded chiefly on Drummond's collections; and it contains a good account of many of the features of the climate and of the colony, many extremely valuable botanical notes on the plants, and figures of eighteen. Dr. Lindley records his obligations to Captain Mangles, R.N., and R. Mangles, Esq., and notices a paper on Western Australia by Dr. Milligan, published in the 'Madras Journal' for 1837.

Mr. J. T. Bidwill, a gentleman long resident both in Sydney and New Zealand, and possessed of a remarkable love of botany and knowledge of Australian plants, visited Moreton Bay and Wide Bay, and formed an excellent herbarium, which included many novelties, and was transmitted to Sir W. Hooker. Mr. Bidwill accompanied me in my excursions around Port Jackson, and impressed me deeply, both then and afterwards in England, with the extent of his knowledge and fertile talents. He was the discoverer of the *Araucaria* which bears his name, and of many other rare and interesting Australian and New Zealand plants. He died in 1851, from the effects of over-exertion, when cutting his way through the forests of eastern Australia, between Wide Bay and Moreton Bay. He was at the time engaged in marking out a new road, but lost his way, and after eight days' starvation was rescued, but only to succumb in acute pain to the injuries he had received.

In 1854, Dr. Harvey, F.R.S., Professor of Botany in Dublin, visited Australia for the purpose of investigating the Algology of its shores; he landed at King George's Sound, went overland to Swan River and Cape Riche, then to Melbourne, Tasmania, and Sydney, forming magnificent collections of *Algæ*, many of which have been already published in the 'Phycologia Australica,' in this work, and elsewhere. Amongst the many zealous collectors of the *Algæ* of the coast, not elsewhere mentioned in this sketch, are G. Clifton, Esq., of Fremantle, Dr. Curdie, of Geelong, Mr. Rawlinson, and Mr. Layard, of Melbourne, and in Tasmania, Mrs. M'Donald Smith, Mrs. W. S. Sharland, and especially the Rev. John Fereday, of Georgetown.

In 1839–42, Count Strzelecki, F.R.S., the accomplished Polish traveller, traversed the south-eastern parts of Australia and Tasmania, but made no botanical collections. His excellent work 'On the Physical Features of New South Wales and Van Diemen's Land' is full of valuable information on all branches of science.

There are other private individuals of whose precise journeys I have no record, but who collected well, and often largely, as Major Vicary, of the Bengal Army, who seems to have been a very acute and indefatigable investigator of the New South Wales Flora, and a set of whose plants he has transmitted to Kew; Mr. Whittaker, who has sent valuable collections from Port Adelaide; Mr. G. Clowes, a gentleman who visited New South Wales for his health, and transmitted to Kew very copious and fine specimens of New South Wales plants. Mr. Robertson and Mr. Frederick Adamson, both settlers in Victoria, have formed very extensive and excellent collections there between the years 1840 and 1855, which have all been sent to Sir W. Hooker.

The Rev. Richard H. Davies has discovered many curious and some new plants on the east coast of Tasmania since the year 1833, which were communicated to Mr. Archer.

Dr. Joseph Milligan, of Hobarton (now Secretary to the Royal Society of Hobarton), has, since the year 1834, visited many parts of Tasmania, and made several most interesting discoveries, especially on its loftiest mountains and east coast.

Mr. Charles Stuart has been employed in Tasmania in collecting, at various times, chiefly, I believe, for Mr. Gunn, ever since the year 1842. Many of his discoveries have been published by Dr. Mueller, and are included in this work.

Dr. Thomas Scott collected in Tasmania, and transmitted specimens to Sir W. Hooker about 1835.

Mr. A. Oldfield (now, I believe, in Western Australia) has carefully investigated the Flora of several parts of Tasmania, and especially of the Huon River, and has also ascended some of its loftiest mountains. His name will be repeatedly found in the Tasmanian Flora, both as a zealous collector and as a careful and acute observer.

It remains only to mention my friend William Archer, Esq., F.L.S., of Cheshunt, who, after a residence of upwards of ten years in Tasmania, during which he sedulously investigated the botany of the district surrounding his property, returned to England in 1857, with an excellent herbarium, copious notes, analyses, and drawings, and a fund of accurate information on the vegetation of his native island, which have been unreservedly placed at my disposal. I am indeed very largely indebted to this gentleman, not only for many of the plants described, and much of the information that I have embodied in this work, but for the active interest he has shown during its whole progress, and for the liberal contribution of the thirty additional plates,* all of which are devoted to the *Orchideæ*, and chiefly made from his own drawings and analyses.

As these pages were being prepared, I have received from Dr. Mueller an interesting botanical account of the Paramatta district, drawn out by W. Woolls, Esq., a zealous Australian botanist.

This brief notice would be neither complete nor satisfactory did it contain no allusion to the important services rendered to the botany of Australia by a few of its most eminent statesmen and settlers, of whom I would specially allude to the late Sir John Franklin, to Sir W. Dennison, Sir George Grey, and Sir Henry Barkly, as Governors, who have specially interested themselves

* The grant of her Majesty's Treasury towards this work is wholly laid out in the payment of the illustrations, and provided for only 170 of these. The remainder were defrayed out of a sum of £100, liberally placed at my disposal by Mr. Archer, to be expended on the work.

in the Botanical Gardens and Expeditions; and amongst private individuals, to Sir William M'Arthur; George M'Leay, Esq.; G. Bennett, Esq., and the distinguished naturalist, W. S. M'Leay, Esq., of Sydney.

P.S. At a meeting of the Linnæan Society, held on the 3rd of November, and after the printing of this Essay was completed, I heard an admirable paper read on the Geographical Distribution of Animals in the Malayan, New Guinea, and Australian continents and islands, by Mr. Alfred Wallace, who is still indefatigably investigating the zoology of those countries. The total absence of information as to the vegetation of New Guinea precludes my attempting any botanical corroboration of one of Mr. Wallace's most striking facts, viz. the complete difference between the zoology of Celebes and Borneo. These countries are separated by the Straits of Macassar, which are very deep, and the former belongs to the Australian zoological province, but the latter to the Malayan. The Straits of Lombok, to the south of those of Macassar, again, are, though only sixteen miles broad, also very deep, and separate in that latitude the Malayan from the Australian zoological province.

In Mr. Wallace's paper (which I have not seen) he appears to have adopted the same general views regarding the distribution of animals which I have promulgated for that of plants in the Introductory Essays to this and the New Zealand Flora; and establishes it on independent evidence of his own obtaining and of convincing strength. Mr. Wallace has further arrived independently at the same conclusion regarding the permanence of vegetable as compared with animal forms, which I have put forth at p. xii. in note.

I would further observe here, to avoid ambiguity, that my friend Mr. Darwin's just completed work "On the Origin of Species by Natural Selection," from the perusal of much of which in MS. I have profited so largely, had not appeared during the printing of this Essay, or I should have largely quoted it.

*Kew, November, 4, 1859.*

# INTRODUCTORY ESSAY

TO

# THE FLORA OF NEW ZEALAND*.

On commencing the Flora of New Zealand I addressed a few remarks to my readers at the Antipodes, in which I represented the advantages of the study of Botany, if only for the utilitarian purpose of acquiring the names of many little known and useful plants that contribute so much to their comfort and enjoyment. In the absence of such aids as are attainable in countries where a knowledge of botany is more generally diffused, the necessary examination and study required to name plants properly by their natural characters is considerable; but by going through the process for himself, the beginner rapidly acquires a knowledge of the structure and anatomy of Natural Orders, Genera, and Species, which will enable him to prosecute the study of their affinities, geographical distribution, and variation, so as greatly to extend the very limited knowledge we possess of these difficult branches of the science. He will discover that an elementary acquaintance with the Natural Orders and Species of plants is not so readily acquired as in many divisions of the animal kingdom, where it is deduced from a consideration of external characters of form, clothing, and colour, or from modifications of conspicuous organs: he must commence with the knife and the microscope, tracing the development of important organs, however minute; and if he desire to obtain that knowledge of the affinities of plants which alone will enable him to prosecute other branches of the science, he can only do so by first making himself thoroughly acquainted with their comparative anatomy.

In the hope of being able to offer some remarks that may facilitate the labours of those who would pursue the higher branches of this science, I shall preface the observations I have to offer on the affinities and distribution of the New Zealand Flora, with some general theoretical views on the origin, variation, and dispersion of species. These are seldom alluded to in such botanical works as are within the reach of the colonist; and, though probably familiar to most of my English readers, I need hardly apologize to the latter for dwelling on them, if they agree with me in considering that it is very necessary for those who set themselves up as systematists, to give their individual impressions upon these important and obscure subjects, the elucidation of which is one great object of their studies. Not only may a naturalist's views be supposed to represent the result of his accumulated experience, but his mode of treating his subject must in many cases be influenced by them, however much he may try to avoid it. For instance, it is natural to suppose that an observer who believes species to be arbitrary divisions of a genus, dependent on the naturalist's choice of characters, will

* Reprinted from the first volume of Dr. Hooker's 'Flora of New Zealand,' published in October, 1853.

adopt widely different conclusions as to their limits and origin, from one who regards them as distinct creations; and he who denies that a plant which grows spontaneously in England and New Zealand can have originated from one common parent, will reason differently on the subject of migration and dispersion from him who holds an opposite view. Now the actual amount of knowledge we possess on such subjects is so very limited, that few experienced naturalists are inclined to pronounce positively upon them, whilst the majority offer no opinion at all. I am very sensible of my own inability to grapple with these great questions, of the extreme caution and judgment required in their treatment, and of the experience necessary to enable an observer to estimate the importance of characters whose value varies with every organ and in every order of plants. I think, however, that there is a mean to be kept between the dogmatism with which a large class of naturalists (generally of very limited experience) decide upon species, and the vagueness which characterizes the writings of others in all that refers to them; this, and the fact that most persons commence botany without any definite idea of what meaning naturalists attach to the term, or of its importance, have also induced me to address some cautions to the student, suggested by those theoretical principles which the study of the New Zealand Flora may help to develope. This I propose to do under three heads or chapters, which will be devoted—1. To the history of New Zealand Botany, showing the labours of my predecessors, the nature and amount of the materials that have been available to myself, and the probable limits of the New Zealand Flora.—2. To the views I have adopted in the descriptive part as to the affinities, limits, origin, variation, distribution, and dispersion of plants generally.—3. To the illustration and development of these views by an analysis of the New Zealand Flora, and its relation to those of other countries.

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## CHAPTER I.

### SUMMARY OF THE HISTORY OF THE BOTANY OF NEW ZEALAND.

For the earliest account of the plants of these Islands we are indebted to two of the most illustrious botanists of their age, and to the voyages of the greatest of modern navigators; for the first, and to this day the finest and best illustrated herbarium that has ever been made in the islands by individual exertions is that of Sir Joseph Banks and Dr. Solander, during Captain Cook's first voyage in 1769. Upwards of 360 species of plants were collected during the five months that were devoted to the exploration of these coasts, at various points between the Bay of Islands and Otago, including the shores of Cook's Straits; and the results are admirable, whether we consider the excellence of the specimens, the judgment with which they were selected, the artistic drawings by which they are illustrated, and above all the accurate MS. descriptions and observations that accompany them. That the latter, which include a complete Flora of New Zealand as far as then known, systematically arranged, illustrated by two hundred copper-plate engravings, and all ready for the press, should have been withheld from publication by its illustrious authors, is (considering the circumstances under which it was prepared) a national loss, and to science a grievous one, since, had it been otherwise, the botany of New Zealand would have been better known fifty years ago than it now is*.

Captain Cook was, on his second voyage, accompanied by three scientific men, all more or less conversant with botany, namely, the two Forsters (father and son), and Dr. Sparrmann, who joined the expedition at the Cape of Good Hope. Queen Charlotte's Sound, in Cook's Straits, and Dusky Bay were the chief points botanized. From the former, as it had been previously explored by Banks and Solander, little novelty was to be expected, and from the latter, which has lately proved so rich in interesting plants, little, comparatively speaking, was brought. About 160 species of flowering plants and Ferns were collected in all, and these were (often inaccurately named) distributed amongst many public and private Museums. I have examined a set in the Paris Museum, another in the Banksian, and a third in my father's†, and in these collections the same plant has sometimes different names; this has given rise to much confusion and synonymy, and false identification of the plants published in the 'Nova Genera Plantarum' and 'Prodromus Floræ Insularum Australium.' The latter work contains descriptions of 150 New Zealand species; these are supposed to have been elaborated by Dr. Sparrmann, and even for the period are very unsatisfactory. Forster's 'Commentatio de Plantis esculentis insularum Oceani Australis' contains better descriptions, and much curious information on the few edible plants of the islands‡. Mr. Anderson, surgeon to Cook's third expedition, undertook the botanical department on that voyage; but though Dusky Bay was visited a second time, nothing of importance was added to its botany. It remained for Mr. Menzies, the surgeon and naturalist of Captain Vancouver's voyage, to discover the cryptogamic riches of New Zealand, and especially those of Dusky Bay. That naturalist devoted himself to the collection of Mosses and Hepaticæ, and this at a time when these objects were scarcely thought worthy of attention, and their structure and functions little known or understood. Most of his collections were placed in Sir William Hooker's hands, and many of them were beautifully illustrated in the 'Musci Exotici.'

For upwards of twenty years after Cook's voyage New Zealand remained unvisited by any naturalist, until Captain Duperrey's expedition in the French surveying corvette the Coquille, in 1822, when he was accompanied by a young officer of great promise, and an ardent collector of plants, the late Admiral D'Urville. This officer revisited New Zealand in 1827, in the same ship (re-named the

* This herbarium and MS. form part of the Banksian collection, and are deposited in the British Museum. I feel that I cannot over-estimate the benefit which I have derived from these materials, and it is much to be regretted that they were not duly consulted by my predecessors. The names by which Dr. Solander designated the species have been in most cases replaced by others, often applied with far less judgment, and his descriptions have never been surpassed for fulness, terseness, and accuracy. The total number of drawings of New Zealand plants is about 212, of which 176 are engraved on copper, but the engravings have never been published; these treasures are accompanied with 24 additional copper-plates from Forster's drawings, of plants which were not found during Cook's first voyage.

† This was presented by the late Mr. Shepherd, of Liverpool, and formed part of what I believe is a very complete collection of Forster's plants. I have to add with regret that the trustees of the institution to which the latter belongs considered it inexpedient to accede to my request that it should be transmitted temporarily to Kew for comparison and publication.

‡ *Solanum aviculare, Coriaria sarmentosa, Convolvulus chrysorhizus* (cult.), *Dioscorea alata* (cult.), *Arum esculentum* (cult.), *A. macrorhizon* (cult.), *Cordyline indivisa, Areca sapida, Apium graveolens, Tetragonia expansa, Lepidium oleraceum, Sonchus oleraceus, Pteris esculenta, Cyathea medullaris, Gleichenia* sp. (*Polypodium dichotomum*), *Leptospermum scoparium, Dacrydium cupressinum.* It is in this work that the *Avicennia tomentosa* is described as *A. resinifera,* with the statement recorded by Crozet of its producing a gum which is eaten by the natives, which no doubt originated in some mistake.

Astrolabe), and accompanied by M. Lesson, a distinguished naturalist. The combined collections of these individuals and two voyages, amounting to 200 species of flowering plants and Ferns, were published by the late Professor A. Richard, in his 'Essai d'une Flore de la Nouvelle-Zélande.' This is a work of considerable merit, in which were included all Forster's plants in the Paris Museum, with extracts from his MSS. that accompany them.

On the establishment of Colonial Gardens and botanists at Sydney, New Zealand became an object of especial interest to the latter, and the Bay of Islands was visited by Mr. Charles Frazer in 1825, by his successor Allan Cunningham in 1826, by Richard Cunningham (brother to the latter) in 1833, and again by Allan in 1838, during which visit this indefatigable collector contracted, through exposure and fatigue, the illness which terminated his life at Sydney in 1839. After his first expedition Allan Cunningham prepared his Prodromus, which was published in detached portions in several botanical periodicals*. In this he enumerated all the previously published species of Forster and A. Richard, but the work is so unsatisfactory and incomplete that were it not for the invaluable herbarium of both Cunninghams, now in Mr. Heward's possession†, I should have found it impossible to have quoted the 'Prodromus' with any degree of confidence.

Amongst the earlier explorers of this period, Dr. Logan, now a resident in the colony, deserves especial mention; his contributions of excellent specimens arriving at a time when New Zealand plants were almost the rarest, and scientifically the most interesting. It is however within the last twelve years, and since New Zealand has attracted the notice of colonists, that the most important accessions to its botany have been made, and it is to correspondents, most of them still alive, and actively engaged in pursuing their investigations, that I am indebted for the materials of these volumes. The Reverend William Colenso, Dr. Andrew Sinclair, R.N., my lamented friend J. T. Bidwill, Esq., Dr. Dieffenbach, M. Raoul, and Dr. Lyall, stand pre-eminent as indefatigable explorers and collectors. Mr. Colenso's researches have extended uninterruptedly over upwards of twelve years, during which he has traversed a great part both of the coast and interior of the Northern Island, and has been the principal contributor to our knowledge of its botany. Dr. Sinclair has also devoted many years to the New Zealand Flora, and has made numerous most interesting discoveries, especially on the east coast, and has transmitted such copious suites of excellent specimens as are most valuable for botanical purposes. Mr. Bidwill and Dr. Dieffenbach were the first explorers of the lofty mountains of the interior: Mr. Bidwill indeed ascended both Tongariro and the Nelson range, and formed collections of the greatest interest and value, accompanied by valuable notes on the elevation at which the plants were gathered, their variations, periods of flowering, and many other important points‡. M. Raoul accompanied the French frigate L'Aube in 1840 and 1841, and again L'Allier in 1842–3, during which voyages he made a very complete botanical exploration of Banks' Peninsula and the Bay of Islands. His admirable collections were deposited in the Jardin des Plantes at Paris, where they were placed at my disposal by M. Raoul, with whom I had the pleasure of examining them in 1845; a complete set was also detached for Sir W. Hooker's Herbarium, and has been of the greatest use to me. A selection from the new species was described by MM. Raoul

* Under the title of 'Floræ Novæ Zelandiæ Præcursor,' in the 'Companion to the Botanical Magazine,' vol. 2, and concluded in the 'Annals of Natural History,' vols. 1, 2, and 3.

† I am indebted to Mr. Heward's liberality for the unreserved use of this extremely valuable collection.

‡ The Nelson Mountains have since been again explored by Dr. Monro, who has added a few remarkable novelties that had escaped Mr. Bidwill's notice, and whose excellent collections are, I hope, an earnest of still further discoveries.

and Decaisne in the 'Annales des Sciences Naturelles*,' and the beautiful 'Choix de Plantes de la Nouvelle-Zélande,' published in 1846, a work accompanied with plates of rare excellence as botanical drawings, and with a careful enumeration† of all known New Zealand plants, compiled from the collections in the Paris Museum, and from M. Richard's and Cunningham's Floras.

In 1847 H.M.St.V. Acheron was commissioned by Captain Stokes, R.N., for the survey of New Zealand, to explore the western and southern coasts; and we are indebted to the exertions of the eminent hydrographer of the navy, Sir Francis Beaufort, for the selection of a naturalist as surgeon to the expedition. My friend Dr. Lyall, in whose company I had formerly botanized in the Bay of Islands during the Antarctic Expedition‡, was selected for the service; and devoting himself, like Mr. Menzies, with indefatigable zeal to the lower Orders especially, he amassed the most beautiful and important collections in these branches of botany, that have ever been formed; besides making considerable discoveries in Phænogamic plants, and collecting many that had previously only been gathered by Banks and Solander and the Forsters.

As far as the discovery of species is concerned, the above enumeration brings me down to the present state of our knowledge of the New Zealand Flora; but it remains for me to observe that within the last three years, indeed since the announcement of this work being forthcoming, I have been favoured with more than a dozen collections from various parts of the island. Of new gleaners in the field, I would especially mention Dr. Monro, Mr. Knight, the Rev. Mr. Taylor, Captain Drury, Mr. Jolliffe, Captain D. Rough, and Lieutenant-Colonel Bolton; all of whom have sent valuable contributions. It is true that these contain little novelty, but they throw light on the distribution of the species, and afford materials for tracing their geographical limits.

From these materials the 'Flora of New Zealand' has been worked up: its probable completeness may be judged of by the fact that the islands have been botanized on by upwards of thirty-five individuals, whose specimens have (with a few unimportant exceptions) all passed under my eye. The Flora of the Northern Island has been tolerably well examined, so far as its flowering plants are concerned; though there remains a good deal to be done on the west coast, especially in the neighbourhood of Mount Egmont. Dr. Lyall alone has collected in the Southern Island, or on the west coast north of Dusky Bay. The Middle Island has been visited by few explorers, its north and east coasts alone having been botanized: the west and the whole mountain range require a careful survey; and considering how many Auckland and Campbell Islands plants are still strangers to New Zealand, it cannot be doubted that much remains to be discovered there. Excepting from the above-mentioned tracts, I do not expect much novelty amongst flowering plants, for the following reasons:—1, there is a remarkable sameness in the flora throughout large tracts§; 2, because out of the 730 flowering plants known, there are scarcely one hundred that have not been gathered by several individuals; 3, because the collections I have lately received, though some of them are extensive, and from scarcely visited localities, yet contain little or no novelty. With Cryptogamia the case is widely different; and it is difficult to estimate the vast number, especially of Mosses, Hepaticæ, and

* Annales des Sciences Naturelles, August, 1844.

† In this enumeration upwards of 500 species of flowering plants are named, but fully one hundred of these are synonyms, introduced species, or erroneous ones of Cunningham and others.

‡ In the above list I have not thought it necessary to allude to the collections made at the Bay of Islands by Dr. Lyall and myself in the Antarctic Expedition: they contained no novelty amongst flowering plants, not known to Mr. Colenso and Dr. Sinclair, with whom I spent many happy days. Amongst Cryptogamic plants I collected much that was then new, but most of the species have since been found elsewhere.

§ In this respect New Zealand contrasts remarkably with Tasmania.

Fungi, that will reward future explorers in what, as far as flowering plants are concerned, are exhausted fields. Upwards of 114 Ferns (including Lycopodia) are already known*, a number which might be swelled by nearly one-half, were all the varieties which have been described as species considered by me as such. I do not anticipate many more novelties in this Order; the species (with few exceptions) having very wide ranges in the islands, and these beautiful plants having always attracted a greater share of attention than others. The foliaceous Cryptogams† (Mosses and Hepaticæ) are by far the most extensive Natural Order of plants (except Fungi) in these islands, as they are of most temperate and especially moist climates. Of Hepaticæ Mr. Mitten enumerates in this work 180, whereas only about 150 are found in all Great Britain; and Mr. Wilson's 'Muscologia of New Zealand' includes 250 species, amongst which are many of the most gigantic, beautiful, and interesting in structure, in the world. I have no doubt that both these Orders will be more than doubled: it requires a practised eye, and some previous knowledge, thoroughly to explore a small district rich in Mosses and Hepaticæ.

In Fungi this flora is still most imperfect, owing to the unattractive appearance of the species to the general observer, and the difficulty of preserving them in a fit state for examination. Mr. Berkeley has undertaken their arrangement, and his are the first observations of any consequence that have ever appeared on the New Zealand species of this curious and most interesting Natural Order, which is by far the largest in the vegetable kingdom. So many of the kinds are minute, and even microscopic, that it is probable that, when properly investigated, there will prove to be upwards of 1000 species in New Zealand.

Much novelty is not to be looked for amongst the foliaceous and larger Lichens, but great additions may be made amongst crustaceous and minute epiphytical species. The New Zealand Algæ, of which Dr. Harvey enumerates nearly 300 species, have from their beauty and singularity long been objects of great interest to the botanist; and by the labours of Menzies, Turner, Bory, Harvey, and Montagne, this Natural Order has been better illustrated than any other. The great amount of novelty contained in the collections of Dr. Lyall, however, received since this work was begun, show that even this department may be greatly increased.

The total number of species brought together in this Flora is nearly 1900, to which upwards of 100 may be added, for the many minute Cryptogamia which I possess, but which are in too imperfect a state for satisfactory determination. This is much more than double the numerical extent of the last enumeration published, that of M. Raoul, who in 1846 enumerates only 920 species, which may be reduced to 770, if the naturalized and erroneous species be eliminated. In 1838 Mr. Cunningham gave 640 species, which should be reduced to 570; in 1832 M. Richard included 350 in his list; Forster's 'Prodromus' has 154; and Banks and Solander's collections amount to 426. This rapid increase of the Flora, which has thus been quintupled in twenty years, is mainly due to the attention which has been devoted to the lower Orders: this may easily be shown; for whereas in all the early enumerations and collections the number of flowering plants exceeds the flowerless, in M. Raoul's Catalogue they are equal, and in the present work the relative proportions are reversed; the Phænogamic plants being to the Cryptogamic as 1 to 1·6; *i. e.* about two to three.

* Banks and Solander described 66 species; Forster enumerates 40; M. A. Richard 57, of which 8 should be expunged; A. Cunningham and M. Raoul 112, from which fully 30 must be deducted, to bring the lists into comparison with my own estimate of 114.

† These were little attended to by the earlier explorers, except Menzies. Banks and Solander collected very few Mosses.

In conclusion, if I may venture to assume a limit to the Flora of New Zealand, from the data at my disposal, and from a comparison of these with those of better investigated countries with which I am familiar, I should regard 4000 as the probable approximation; of which 1000 may be flowering plants. Compared with any other countries in the same latitude, this is a very scanty Flora indeed, especially as regards flowering plants; of which Britain contains, in about the same area, upwards of 1400 species; and in Tasmania, not yet well explored, and only containing one-third of the area, upwards of 1000 have already been discovered. In Cryptogamic plants, on the other hand, these islands are extremely rich; not only proportionately to the Phænogamic, but absolutely so. Great Britain, where these lower Orders have been assiduously studied for fifty years, contains about fifty Ferns, and Tasmania sixty-four.

In the above remarks I have not alluded to the Floras of some outlying islands, all of which have more or less claim to be considered botanically as a part of New Zealand. Of these, the extent of its Flora renders Norfolk Island the most important: it contains many more tropical forms than New Zealand, and is also more closely connected with the Pacific and Australian Floras. Chatham Island* has been visited by Dr. Dieffenbach, who brought thence a very few plants, all identical with or closely allied to New Zealand species. Lord Auckland's Group and Campbell's Island were investigated by myself in the Antarctic Expedition, and also by the French and American Antarctic Expeditions, under Admiral D'Urville and Commodore Wilkes. All the known species have been published in the first volume of the 'Antarctic Flora;' they are almost all identical with or closely allied to New Zealand plants, and amongst them are found a few Antarctic American ones, not hitherto discovered in New Zealand. They include 370 species, of which 100 are flowering plants, and of these again 54 are known natives of New Zealand. As however neither these islands, nor the mountains of the Middle Island of New Zealand, have been explored satisfactorily, it is probable that a much larger proportion of their flora is common to both.

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## CHAPTER II.

### ON THE LIMITS OF SPECIES; THEIR DISPERSION AND VARIATION.

It is no part of my present object to discuss the theoretical views that have been entertained on these obscure subjects: my aim is to draw attention to a few leading questions of great practical importance, which ought not to be overlooked, even if they do not force themselves on the notice of naturalists. In explanation of my meaning I shall assume certain positions†, and adopt them as principles

* A few Chatham Island plants were engraved in Paris many years ago for a magnificent work, 'Voyage de la Venus;' but the letterpress of that publication has never appeared, nor has the Botany of that voyage been completed.

† I need hardly remark that these have no claim to originality; they are merely selected as heads of the subjects upon which I intend to enlarge.

or axioms; and they shall have the advantage of being simple, intelligible, and as little exposed to the charge of being speculative, as any of that nature can be. I shall assume then—

§ 1. That all the individuals of a species (as I attempt to confine the term) have proceeded from one parent (or pair), and that they retain their distinctive (specific) characters.

§ 2. That species vary more than is generally admitted to be the case.

§ 3. That they are also much more widely distributed than is usually supposed.

§ 4. That their distribution has been effected by natural causes; but that these are not necessarily the same as those to which they are now exposed.

## § 1.

Although in this Flora I have proceeded on the assumption that species, however they originated or were created, have been handed down to us as such, and that all the individuals of a unisexual plant have proceeded from one individual, and all of a bisexual from a single pair, I wish it to be distinctly understood that I do not put this forward intending it to be interpreted into an avowal of the adoption of a fixed or unalterable opinion on my part. Whether or not such a theory be consonant with that great mystery, the origin of organic beings, animate and inanimate, is not the point I would here dwell upon; but the fact that it appears to me essential that the systematist should keep some such definite idea constantly before him, to give unity to his design, and to guide him in the more or less arbitrary restriction of the species of a variable genus, to which he is unfortunately often obliged to resort. Except he act upon the idea that for practical purposes at any rate species are constant, he can never hope to give that precision to his characters of organs and functions which is necessary to render his descriptions useful to others; for in groups where the limits of species cannot be traced (or, what amounts to the same thing in the opinion of many, where they do not exist), the object of the systematist is the same as in groups where they are obvious,—to throw their forms into a natural arrangement, and to indicate them by tangible characters, whose value is approximately relative to what prevails in genera where the limitation of species is more apparent.

In the present imperfect state of our knowledge of the botany of any large area, we have not the materials for solving the great questions as to the origin and permanence of species, upon general principles. A careful comparative study of the Floras of temperate North America and Europe, or of any similarly extensive countries, would throw great light on this subject; or a study of the variations of those plants (and they are not a few) which are common to the five great divisions of the globe. But these branches of botany are so neglected, that I am not acquainted with a British* or Continental Flora, which attempts to give a general view of the variation and distribution of the species described in it. I have to some extent attempted this for the New Zealand Flora; but it would have been manifestly impossible to have concluded this work within a reasonable time, had I made a

* In Mr. Hewett Watson's 'Outlines of the Geographical Distribution of British Plants,' and 'Cybele Britannica,' will be found, amongst a mass of valuable information respecting the Flora of the British Isles, the only detailed account of the distribution of species within our own shores, and (in the first-mentioned work) a sketch of their dispersion over the globe as far as was then known. I am given to understand that Mr. Watson is still engaged on the subject, and most sincerely hope that he is so. A more important desideratum to the British Flora cannot be named, nor one that would tend more to give that direction to the studies of our local botanists, which is so grievously wanted: leading them to the investigation of species as members of the vegetable kingdom, and not as inhabitants of the British Isles only.

critical examination of all the forms from all countries, of those New Zealand species which are cosmopolitan; such operations must necessarily be left to my successors, who may receive many of my remarks on the dispersion of the species simply as suggestions.

A want of materials is not, however, my only reason for withholding a decided assent to the view I have enunciated. There are other theories which claim more or less consideration from every unprejudiced naturalist; and there are such theoretical and practical difficulties (and perhaps impossibilities) in the way of our coming to any conclusions as to the limits of the species of many genera, as give colour to the assumption that they have no permanently recognizable limits. A statement of some of these views and difficulties may be the means of throwing much light on this subject; and they are well worthy of the consideration of the New Zealand botanist; for islands situated far from continents, and in the midst of great oceans, offer many favourable points from which to start in such investigations.

1. Very many naturalists consider species as permanently distinct, but demand a plurality of parents to account for their extensive distribution.

2. Another large class do not consider species as permanent at all, and hold that what are called such, are stirpes or races (like those of man, and such of the lower animals as dogs, horses, etc.), subject to change or obliteration, which have been either accidentally produced, or developed according to some theoretical law.

3. A third class believe in a progressive development of all organized nature, from the cell to an ideal type of perfection, towards which man is the last step reached.

4. Others subscribe to various shades of these opinions, or blend them as far as they consistently can; some, taking even a much larger view of the limits of variability consistent with permanence of type than I profess to have adopted, think genera of plants permanent types, and species accidentally produced varieties.

Arguments in favour of these views are not wanting, derived both from the animal and vegetable kingdoms; the chief of which are drawn from a large class of well established facts, upon the bearings of which the most distinguished and candid naturalists are divided in opinion: such are—the great number of genera whose species have baffled all attempts at circumscription by fixed characters,—the facility with which breeds of certain plants and animals may be propagated, and the comparative certainty with which some few varieties are reproduced under favourable circumstances,—the great facility with which many plants hybridize, and the fact of hybrids having proved fertile,—the sudden appearance and unexplained cause of many varieties or sports,—and the difficulty of accounting for the existence of plants and animals in two or more localities, between which they cannot have been transported by natural causes now in operation. These are all questions relating to the diffusion and variation of species, which will be discussed here and in the following section.

Arguments in favour of the single creation, and permanence of species, are all based upon general considerations of the phenomena of distribution. Comparative anatomy, which has thrown such great light upon this branch of study in the sister kingdom, has not done so much for plants; this arises from several causes:—1. The habits of allied plants do not differ so remarkably as those of animals, and there is consequently less modification of their functional organs.—2. The relation of these modifications to the habits and wants of the species, is in the animal kingdom directly appreciable, but in plants no such connection can be traced*.—3. The individual organs of support,

* The structure of woods offers many illustrations of this; very closely allied plants (especially *Leguminosæ*) differing entirely in the nature, arrangement, and development of the vascular and cellular tissues of their trunks.

respiration, and reproduction, are infinitely more variable and susceptible of change and even obliteration in plants, without affecting the life either of the individual or of the species*. The result of these facts is that we have the means in animals of appreciating the extent and value of differences, by combined observations upon structure and functions, upon habits and organization, which we have not in the vegetable kingdom, and which the phenomena of cultivation assure us do not exist to a degree that has, within the limits of our experience, proved available for throwing much light on the subject.

The arguments in favour of the permanence of specific characters in plants are:—

1. The fact that the amount of change produced by external causes does not warrant our assuming the contrary as a general law. Though there are many notorious cases in which cultivation and other causes produce changes of greater apparent value than specific characters generally possess, this happens in comparatively very few families, and only in such as are easily cultivated. In the whole range of the vegetable kingdom it is difficult to produce a change of specific value, however much we may alter conditions; it is much more difficult to prevent an induced variety from reverting to its original state, though we persevere in supplying the original conditions; and it is most difficult of all to reproduce a variety with similar materials and processes†.

2. In tracing widely dispersed species, the permanence with which they retain their characters strikes the most ordinary observer; and this, whether we take such plants as have been dispersed without the aid of man (as *Sonchus oleraceus, Callitriche,* and *Montia*) through all latitudes from England to New Zealand; or such as have within modern times followed the migrations of man (as *Poa annua, Phalaris Canariensis,* Dock, Clover, *Alsine media, Capsella bursa-pastoris,* and a host of others); or such as man transports with him, whether such temperate climate plants as the cerealia, fruits, and flowers of the garden or field, or such tropical forms as *Convolvulus Batatas* and yams, which were introduced into New Zealand by its earliest inhabitants;—all these, in whatever climate to which we may follow them, retain the impress of their kind, unchanged save in a trifling degree.

Though to a great extent these differences accompany a habit of growth (as in the case of erect and scandent *Bauhinias*), there is nothing in the abnormally developed wood of the climbing *Bauhinia* that would lead a skilled physiologist ignorant of the fact to say that it was better adapted to a climbing than to an erect plant; the function is experimentally known to be indicated by the structure, but the structure is not seen to be adapted to the function. This is not so in the sister kingdom, for we confidently pronounce an animal to be a climber, because we see that its organs are adapted to the performance of that function; here the habit is not only indicated by the structure, but the latter is explained by the function which it enables the animal to fulfil.

* To take an extreme case of this;—many plants are known, in a wild and cultivated state, which propagate abundantly by roots or division, where they do not do so by seed. *Anacharis Alsinastrum* is a conspicuous example: it is a unisexual water-plant, of which one sex alone was introduced from North America into England, where it has within a few years so spread by division as to be a serious impediment to inland navigation. The Horse-radish is another example, it being, I believe, never known to seed or even to bear perfect flowers. A still more remarkable case has been pointed out to me by Mr. Brown, in the *Acorus Calamus*, a plant spread (not by cultivation) over the whole north temperate hemisphere, which bears hermaphrodite flowers, but very rarely seeds.

† I am quite aware that this argument will be met by many instances of change produced in our garden plants: but, after all, the skill of the gardener is successfully exerted in but few cases upon the whole: out of more than twenty thousand species cultivated at one time or another in the Royal Gardens of Kew, how few there are which do not come up, not only true to their species, but even to the race or variety from which they spring; yet it would be difficult to suggest a more complete change than that from the Alps or Polar regions to Surrey, or from the free air of the tropics to the thoroughly artificial conditions of our hothouses. Plants do not accommodate themselves to these changes: either they have passive powers of resisting their effects to a greater or less degree, or they succumb to them.

3. With comparatively few exceptions, plants are confined within well-marked limits, which, though often very wide, are sometimes as much the reverse; while the instances are rare of sporadic species, as such are called which are found in small numbers in widely sundered localities. These facts seem incompatible on the one hand with the theory of species spreading from many centres, and on the other with their varying indefinitely; for were it otherwise, sporadic distribution would be the rule, insular floras would not necessarily be peculiar, and similar climates would have similar, if not identical species, which is not the case.

4. A multitude of allied species of plants grow close together without any interchange of specific character; and there are instances of exceedingly closely allied plants keeping company under many modifications of climate, soil, and elevation, yet never losing their distinctive marks.

5. The individuals that inhabit the circumference of the area occupied by a species, are not found passing into other species, but ceasing more or less abruptly; their limits may meet or overlap those of one or more very similar species, when the individuals associate, but do not amalgamate.

6. One negative argument in favour of distribution from one centre only, is, that taking the broadest view of the dispersion of species, we find that the more extensive families* are more or less widely distributed, very much in proportion to the facilities they present for dispersion. Thus the most minute-spored Cryptogams† are the most widely dispersed of all organized nature; plants that resist the influence of climate best, range furthest; water-plants are more cosmopolite than land-plants, and inhabitants of salt, more than those of fresh water: the more equable and uniform is the climate of a tract of land, the more uniformly and widely will its plants be distributed.

7. The species of the lowest Orders are not only the most widely diffused, but their specific characters are not modified by the greatest changes of climate, however much their stature and luxuriance may vary. Fungi offer a remarkable instance of this: their microscopic spores are wafted in myriads through the air; the life of the individuals is often of very short duration, and many of them being as sensitive as insects to temperature and humidity, they are ephemeral in all senses; sometimes appearing only once in the same spot, and remaining but a few days, never to reappear within the observer's experience. The specific characters of many reside in the diameter, form, colour, and arrangement of their most minute organs, whose analysis demands a refinement of microscopic skill; yet the most accomplished and profound botanist in this Natural Order (who has favoured me with the descriptions of the New Zealand Fungi) fails to find the most trifling character by which to separate many New Zealand species from European.

8. The fact, now universally conceded by all intelligent horticulturists, that no plant has been acclimated in England within the experience of man, is a very suggestive one, though not conclusive; for it may be answered, that plants which cannot survive a sudden change, might a slow and progressive one. On the other hand, plants have powers of enduring change when self-propagated that they have not in our gardens; thus I find a great difference in the hardiness of individual species of several Himalayan plants‡, depending upon the altitude at which they were gathered. In these

* This rule does not extend to the Natural Orders themselves. The *Compositæ*, whose facilities for dispersion are proverbial, are amongst the most local; and the same may be said of *Leguminosæ* and *Solaneæ*, whose seeds retain their vitality in a remarkable degree: a few of their species are remarkably cosmopolite, but the greater number have generally narrow ranges.

† The fact (first communicated to me by the Rev. M. J. Berkeley) of the spores of Fungi having been found by Professor Ehrenberg mingled with the atmospheric dust that has fallen on ships far out at sea, is one of the most decisive proofs of this.

‡ Thus some of the seedling Pines whose parents grew at 12,000 feet appear hardy, whilst those of the same

cases the species is the same, and the parent individuals were not even varieties of one another, except so far as regards hardiness; in other words, the specific character remains unaltered in spite of the change of constitution, just as the climate of one part of the globe disagrees with the human race of another, and is even fatal to it.

Such are a few of the leading phenomena or facts that appear to me to give the greatest weight to the opinion that individuals of a species are all derived from one parent: for such arguments as the New Zealand Flora furnishes, I must refer my readers to the following chapter. I would again remind the student that the hasty adoption of any of these theories is not advisable: plants should be largely collected, and studied both in the living and dried states, and the result of their dissection noted, without reference to any speculations, which are too apt to lead the inquirer away from the rigorous investigation of details, from which alone truth can be elicited. When however the opportunity or necessity arises for combining results, and presenting them in that systematic form which can alone render them available for the purposes of science, it becomes necessary for the generalizer to proceed upon some determinate principle; and I cannot conclude this part of the subject better than by adopting the words of the most able of Transatlantic botanists, who is no less sound as a generalizer than profound in his knowledge of details:—"All classification and system in Natural History rests upon the fundamental idea of the original creation of certain forms, which have naturally been perpetuated unchanged, or with such changes only as we may conceive or prove to have arisen from varying physical influences, accidental circumstances, or from cultivation*."

## § 2.

*Species vary in a state of nature more than is usually supposed.*

The views entertained as to the limitation of species appear to be quite arbitrary: no general principles have been discovered for the guidance of the systematist; and those that are adopted vary in kind and in value with every natural group. It is not therefore surprising that two naturalists, taking opposite views of the value of characters, should so treat a variable genus that their conclusions as to the limits of its species should be wholly irreconcilable. Some naturalists consider every minute character, if only tolerably constant or even prevalent, as of specific value; they consider two or more doubtful species to be distinct till they are proved to be one; they limit the ranges of distribution, and regard plants from widely severed localities as almost necessarily distinct; they do not allow for the effects of local peculiarities in temperature, humidity, soil, or exposure, except they can absolutely trace the cause to the effect; and they hence attach great importance to habit, stature, colour, hairiness, period of flowering, etc. These views, whether acknowledged or not, are practically carried out in many of the local floras of Europe, and by some of the most acute and observant botanists of the day; and it is difficult to over-estimate the amount of synonymy and confusion which they have introduced into the nomenclature of some of the commonest and most variable of plants. In such hands the New Zealand genera *Coprosma*, *Celmisia*, *Epilobium*, etc., may be indefinitely extended. The principles I have adopted are opposed to these: I have based my conclusions

species from 10,000 are tender. The common scarlet *Rhododendron* of Nepal and the North-west Himalaya is tender, but seedlings of the same species from Sikkim, whose parents grew at a greater elevation, have proved perfectly hardy.

* Botanical Text-book, p. 303, by Professor Asa Gray, of Cambridge University, U.S.

on this subject upon a very extensive examination of living plants in all latitudes, with my attention particularly directed to the influence of external causes, not only on the general phenomena of vegetation, but also upon individuals. Added to this, I have paid a great deal of attention to variable plants, both of tropical and temperate climates, and studied them in a living state, both wild and cultivated, and also in the herbarium. The result of my observations is, that differences of habit, colour, hairiness, and outline of leaves, and minute characters drawn from other organs than those of reproduction, are generally fallacious as specific marks, being attributable to external causes, and easily obliterated under cultivation. It has hence been my plan to group the individuals of a genus which I assume after careful examination to contain many species whose limits I cannot define, that the species shall have the same relative value as those have of allied genera whose specific characters are evident. I doing so I believe I have followed the practice of every systematist of large experience and acknowledged judgment since the days of Linnæus, as Bentham, Brown, the De Candolles, Decaisne, Asa Gray, Jussieu, Lindley, and the Richards; names which include not only the most learned systematists, but the most profound anatomists and physiologists. I am far from supposing that the same materials of a difficult group would receive precisely similar treatment at the hands of each of these eminent men; but their results would so closely approximate as to be in harmony with each other, and available for scientific purposes: with all, the tendency would be to regard dubious species as varieties, to take enlarged views of the range and variation of species, and to weigh characters not only *per se*, but with reference to those which prevail in the Order to which the species under consideration belong.

In working up incomplete floras especially, I believe it to be of the utmost importance to adopt such a course, and to resist steadily the temptation to multiply names, for it is practically very difficult to expunge a species founded on an error of judgment or observation*. There is further an inherent tendency in every one occupied with specialities to exaggerate the value of his materials and labours, whence it happens, that botanists engaged exclusively upon local floras are at issue with those of more extended experience, the former considering as species what the latter call varieties, and what the latter suspect to be an introduced plant the former are prone to consider a native. There is much to be said on both sides of such questions: the local botanist looks closer, perceives sooner, and often appreciates better, inconspicuous organs and characters, which are overlooked or too hastily dismissed by the botanist occupied with those higher branches of the science, which demand a wider range of observation and broader views of specialities; and there is no doubt but that the truth can only be arrived at through their joint labours; for a good observer is one thing, and the knowledge and experience required to make use of facts for purposes of generalization, another: minute differences however, when long dwelt upon, become magnified and assume undue value, and the general botanist must always receive with distrust the conclusions deduced from a few species of a large genus, or from a few specimens of a widely distributed plant.

I have been led to dwell at length upon this point, because I feel sure the New Zealand student will at first find it difficult to agree with me in many cases, as for instance on so protean a Fern as *Lomaria procera*, whose varieties (to an inexperienced eye) are more dissimilar than are other species of the same genus. In this (and in many similar cases) he must bear in mind that I have examined

* The state of the British flora proves not only this, but further, that one such error leads to many more of the like kind: students are led to over-estimate inconstant characters, to take a narrow view of the importance and end of botany, and to throw away time upon profitless discussions about the difference between infinitely variable forms of plants, of whose identity really learned botanists have no doubt whatever.

many hundred specimens of the plant, gathered in all parts of the south temperate hemisphere, and have found, after a most laborious comparison, that I could not define its characters with sufficient comprehensiveness from a study of its New Zealand phases alone, nor understand the latter without examining those of Australia, South Africa, and South America. The resident may find two varieties of this and of many other plants, retaining their distinctive characters within his own range of observation (for that varieties often do so, and for a very uncertain period, both when wild and also in gardens, is notorious), and he may perhaps have to travel far beyond his own island to find the link I have found, in the chain of forms that unites the most dissimilar states of *Lomaria procera;* but he can no more argue thence for the specific difference of these, than he can for a specific difference between the aboriginal of New Zealand and himself, because he may not find intermediate forms of his race on the spot. We do not know why varieties should in many cases thus retain their individuality over great areas, and lose them in others; but the fact that they do so proves that no deductions drawn from local observations on widely distributed plants can be considered conclusive. To the amateur these questions are perhaps of very trifling importance, but they are of great moment to the naturalist who regards accurately-defined floras as the means for investigating the great phenomena of vegetation; he has to seek truth amid errors of observation and judgment, and the resulting chaos of synonymy which has been accumulated by thoughtless aspirants to the questionable honour of being the first to name a species*.

There are many causes which render it extremely difficult to determine the limits of species, and in some genera the obstacles appear to increase, the more the materials for studying them multiply, and the more we follow our analysis of them into detail; hence the botanist is often led on to an indefinite multiplication of species (with increased difficulty of determining those already established), or to a reduction of all to a few, or to one variable species. My own impression is, that the progress of botany points to the conclusion that in many genera we must ultimately adopt much larger views of the variation of species than heretofore, and that the number of supposed kinds of plants is (as I shall indicate elsewhere) greatly over-estimated; if it be not so, we must either admit that species are not definable, or that there are hidden characters throughout all classes of the vegetable kingdom, of which the botanist has no cognizance, and towards the acquirement of which, if they are ever to be revealed, all efforts in the direction in which we have been advancing appear to be vain. Could systematists as a body be accused of carrying out their investigations in an unphilosophical manner or spirit, or without due attention to all the modes of testing the validity of characters, afforded by the study of living and dried plants, by direct observation, and by experiment, there might be hopes of such a revelation; but such hopes are inconsistent with the great advances that have been made in systematic botany, which, having all tended to a more perfect knowledge of the affinities of plants, we are assured have been the effect of progress in the right direction.

Of the genera to which I here allude as variable, there are many in New Zealand†; some of

* The time however is happily past when it was considered an honour to be the namer of a plant; the botanist who has the true interests of science at heart, not only feels that the thrusting of an uncalled-for synonym into the nomenclature of science is an exposure of his own ignorance and deserves censure, but that a wider range of knowledge and a greater depth of study are required, to prove those dissimilar forms to be identical, which any superficial observer can separate by words and a name.

† M. Bory de St. Vincent has observed (Voyage dans les Quatre principales Iles des Mers d'Afrique) with reference to insular floras, that their species are generally variable, an hypothesis scarcely compatible with the fact that the proportion of species to genera in islands is always small, because the proportion of imported plants, which is considerable in an island, is made up of species of different genera, having no affinity with one another, and

these are mundane, that is, found in all or most temperate or tropical climates, as *Ranunculus*, *Clematis*, *Senecio*, and many Grasses and Ferns; and we cannot yet tell whether the difficulties are greater with them than with the more local or endemic genera, as *Coprosma*, *Celmisia*, *Alseuosmia*, and *Dracophyllum*. Of the mundane genera again, some are chiefly composed of species which are local (as is the case with the three first mentioned), while of others the species themselves are widely distributed, as those of *Potamogeton*, *Lemna*, and many Ferns.

The fact of a plant having a wide range implies its being exposed to climatic differences that often induce change, and the consequent propagation of forms or races that cannot be recognized as members of one species, without full series of specimens from many localities. If we allow a sufficient time, it is quite reasonable to suppose that geological or other natural causes (producing a change of climate) may isolate by sea or desert, or by the intrusion of stronger plants that monopolize the soil, the outlying abnormal states of a species that was once uniformly spread over an area. To connect those dissevered members is often a work of great difficulty, for individuals of such races frequently retain their character even when they have been under cultivation for many years.

Hybridization has been supposed by many to be an important element in confusing and masking species*. Nature, however, seems effectually to have guarded against its extensive operation and its effects in a natural state, and as a general rule the genera most easily hybridized in gardens, are not those in which the species present the greatest difficulties. With regard to the facility with which hybrids are produced, the prevalent ideas on the subject are extremely erroneous. Gärtner, the most recent and careful experimenter, who appears to have pursued his inquiries in a truly philosophical spirit, says that 10,000 experiments upon 700 species produced only 250 true hybrids†. It would have been most interesting had he added how many of these produced seeds, and how many of the latter were fertile, and for how many generations they were propagated. The most satisfactory proof we can adduce, of hybridization being powerless as an agent in producing species (however much it may combine them), are the facts that no hybrid has ever afforded a character foreign to that of its parents, and that hybrids are generally constitutionally weak, and almost invariably barren. Unisexual‡ trees must offer many facilities for the natural production of hybrids, which, nevertheless, have never been proved to occur, nor are such trees more variable than hermaphrodite ones.

nothing in common but their facility for transportation. From the above-mentioned hypothesis it would hence result that whilst the differences of one degree (specific) are small and inconstant, those of a higher degree (generic) are great and trenchant. To a certain extent, however, these facts are not incompatible, for we can imagine a flora wholly composed of a few genera as well marked (generically) as *Coprosma* and *Alseuosmia*, whose species may yet be as undefinable; or again, species may be well marked, yet variable in characters which would in no one's opinion be of specific value.

* Hybridization as an agent in confusing species is a very favourite argument with those who are fond of founding species on inconstant characters; when shown a specimen combining two such spurious species, they at once pronounce it a hybrid—a very simple way of getting rid of a difficulty. In Ferns, the most variable of all plants, hybrids were once generally admitted to exist, but the observations of Suminski have led to the discovery of their sexual organs, whose arrangement and structure seem to preclude the possibility of such a phenomenon.

† See his observations on muling, Hort. Soc. Journ. vol. v. and vi. 1850–1851.

‡ Unisexual plants are very interesting in many points of view, and in none more than in the varying development of the sexes according to circumstances. Observations on this subject are very much wanted: it has been stated to depend on local circumstances whether the seeds of a bisexual plant shall come up male or female; and the fact of both kinds of flowers, or even of hermaphrodite flowers, often occurring on a plant that usually perfects one sex only (as in the monœcious Hop-plant described by Mr. Masters in Gard. Chron. 1847), shows that we may even speculate on the possibility of diœcious plants having sprung originally from a single parent, whose off-

These considerations lead us to others still more elusive of the naturalist's grasp. The reference of all varieties to a species, and of its individuals to a single parent, argues the existence at some epoch of a type or form around which all varieties may be grouped. It has been observed that two or more created or induced types or species may resemble one another so closely, that, amid the multitude of varieties of each, the naturalist shall seek in vain for that which best demonstrates the species. No one can deny the possibility of such creations, nor perhaps their probability, when he considers the infinite varieties of climates, how insensibly they pass into one another, and how nicely the functions of some plants appear to be adapted to certain modifications of these, and to no others. Had, moreover, every climate its own species, and were there any difficulty in propagating the majority of the plants of one climate in a very different one, such creations would appear to be indispensable: but the facts of botanical geography assure us, that it is by far the smaller half of the vegetable kingdom that is confined to narrow geographical or climatic areas, and that very few plants indeed are absolutely local; whilst the operations of the gardener and agriculturist prove, that a vast proportion of the plants of the two temperate zones are capable of growing in any moderate climate. I do not think that those who argue for narrow limits to the distribution and variation of species, can have considered a garden in a philosophical spirit, or have weighed such facts as that there have been cultivated, within the last seventy years, in the open air of England (at Kew) upwards of twenty thousand species of plants from all quarters of the globe, and this within a space that, had it been left to nature, would not have contained two hundred indigenous species! The fact that an overwhelming proportion of these have come up true to their parent, and have continued so under every possible disadvantage of transportation and transplantation, of altered seasons, and amount and distribution of temperature and humidity, of unsuitable soil and exposure, and of the multitude of errors in management which unavoidable ignorance of their natural locality and habit engenders. Such appears to me the most forcible argument in favour of the power of plants to retain their original characters under altered circumstances.

To return however to the idea of a type, I must remind the New Zealand reader that the word is often used in a vague and unphilosophical manner: in the too frequent sense of the term it denotes that individual of a species which was first cultivated, described, figured, or collected, or that form which is most abundant in the neighbourhood of the writer; whereas all the individuals thus referred to may represent anomalous or exceptional states of the true type. The fact is, that we have no clue whatever to the originally created typical form of any plant, consistent with the view of its origin in a single parent, and its powers of varying. If we take a species of universal distribution, a careful examination of all its variations, and a contrast between these and those of its allies, may lead to the detection of a form, which for various reasons may be assumed as the real or ideal standard; for we have no reason to suppose that the whole globe is so altered that the circumstances under which the assumed type originally appeared do not now exist anywhere. But with local plants the case is different; they may have originated where they are now found, but it is more consistent with geological truths to assume that many did not, and that, however slight the induced changes have been, and however powerless to obliterate specific character, they may still mask the original form.

Practically, then, the type is a phantom; what was once the typical state may no longer be the

spring by altered circumstances have become unisexual, and, what is of more practical importance, upon the possibility of the chance transport of one sex of a diœcious plant proving sufficient to effect the propagation of the species.

common one, or that which now fulfils the office the species did at an earlier epoch*. For practical purposes we must assume the most common form to be the most typical, for it is that which is best known. In doing this, however, there is extreme difficulty in combating local prejudices; the general botanist cannot give a higher place in the great scheme of Nature to a natural object on account of its beauty, rarity, or local associations, any more than he can call a doubtful plant a native because it looks well in his flora or herbarium; but there are local observers who cannot be brought to see things in such a light, and who take the exclusion of plants accidentally introduced into the flora of their neighbourhood, and the reduction of supposed local types to varieties of better known and wider spread plants, as little short of an insult to their understandings, and a slight upon the natural history of their village or island, and suppose that because the systematist cannot see with their eyes he therefore takes a less true interest in what he observes.

## § 3.

*Species are more widely diffused than is usually supposed.*

This is a point upon which my own views differ materially from those of many of my fellow botanists, and which, if borne out by facts, leads to a widely different estimate of the number and variety of the members of the vegetable kingdom than that which is at present entertained. As with the affinities and variation of species, so is it with their distribution: an extensive knowledge of the subject is only to be obtained by actual observation over large areas, and many of them, or by the study and comparison of the contents of many museums. It has been my singular good fortune to have visited many regions of the globe, and to have entered into some details upon the dispersion of living species, which has always been a favourite pursuit of mine. I have further had the advantage of collating my results with the largest and best-named botanical collections in the world, and have received a greater amount of assistance from my fellow naturalists than has fallen to the lot of most: facts which in ordinary cases are the result of long study and much consultation have been placed at my disposal rather than worked out by myself†. A very extended examination of these materials has only tended to confirm the view which originated in my personal experience, viz. that the esti-

* Thus the few remaining native Cedars of Lebanon may be abnormal states of the tree which was once spread over the whole of the Lebanon, for there are now growing in England varieties of it that have no existence in a wild state. Some of these closely resemble the Cedars of the Atlas and of the Himalayas (*Deodar*), and the absence of any valid botanical differences between these three forms tends to prove that all, though generally supposed to be different species, are one. The characters by which these Cedars are distinguished reside in habit, colour, and length of leaf, and are in process of change and obliteration under cultivation; if we find, then, these plants to be varieties of one which is dispersed from the Atlas Mountains to Northern India, which of the three can we assume as the type, but that which retains its characters over the greatest area, viz. the Cedar (*Deodar*) of the Himalaya? whether or not that was the originally created state, or whether the species was created there or in the Atlas or in Lebanon, or in some intermediate area whence it is now banished. It will be difficult to disconnect the idea of the common Cedar from that of the type of its race, but the systematist may have to do so. What thus happens with large trees may likewise occur with smaller plants. I have given the most conspicuous illustration with which I am familiar, but in the eyes of a naturalist it is not in the least more significant than one drawn from the study of the varieties and distribution of a Moss or Grass.

† It is impossible to over-estimate the importance of a well-studied and named herbarium for such purposes, a simple inspection of many species often giving their geographical range, and in the numerous cases in which widely distributed genera have been worked up by competent authorities, the results are obtained with great accuracy.

mate of the number of species known to botanists is a greatly exaggerated one*, and the prevalent ideas regarding their distribution no less contracted.

Many more plants are common to most countries than is supposed; I have found 60 New Zealand flowering plants and 9 Ferns to be European ones, besides inhabiting various intermediate countries; and amongst the lower Orders we find a greatly increased proportion of species common to all countries: thus of Mosses alone 50 are found in New Zealand and Europe†; of Hepaticæ 13; of Algæ 45 are also natives of European seas; of Fungi nearly 60; and of Lichens 100.

So long ago as 1814 Mr. Brown‡ drew attention to the importance of such considerations, and gave a list of 150 European plants common to Australia. The identity of many of these has repeatedly been called in question, but almost invariably erroneously, added to which more modern collectors have greatly increased the list.

The too prevalent idea that the plants of newly discovered, isolated, or little visited localities must necessarily be new, has been a fertile source of the undue multiplication of species. There are very many cases of naturalists having been so impressed with this idea, that they have not thought it worth while to consult either books or herbaria before describing the plants from such spots. The New Zealand Flora presents several instances of this; two conspicuous ones occur in the genus *Oxalis*; one, *O. corniculata*, is amongst the most widely diffused and variable plants in the world; of its varieties no less than seven or eight species have been made, most of them supposed to be peculiar to New Zealand; not only is *O. corniculata* hence excluded from the flora, but in the descriptions of these its varieties, no allusion is made to that plant§. In the case of the other species the error is more excusable, and may be still open to question‖; it is that of *O. Magellanica*, originally discovered in Fuegia, and imperfectly described by Forster, whose very indifferent specimens of it are in the

* According to the loose estimate of compilers, 100,000 is the commonly received number of known plants: from a multiplicity of data I can come to no other conclusion but that half that number is much nearer the truth. This may well be conceived, when it is notorious that nineteen species have been made of the common Potato, and many more of *Solanum nigrum* alone. *Pteris aquilina* has given rise to numerous book species, *Vernonia cinerea* of India to fifteen at least. Many of the commonest European plants have several names in Europe, others in India, and still others in America, besides a host of garden names for themselves, their hybrids and varieties, all of which are catalogued as species in the ordinary works of reference whence such estimates are compiled.

† In fact the distribution of some Cryptogams is so wide, that I have visited a spot in a high southern latitude, nearly all whose plants are not only identical with those of Great Britain, but inhabit many intermediate temperate and tropical countries. Cockburn Island, in lat. 64° 12′ S. and long. 64° 49′ W., nearly fulfils this condition; I thereon collected nineteen plants, of which three-fourths are natives of England.

‡ Appendix to Flinders's Voyage, vol. ii. p. 592.

§ I have stated very confidently in the body of this work that eight of Cunningham's and Richard's species of this genus are all referable to one. This view will probably not meet the approbation of the local botanists, who will point to the constancy with which some of the states retain their characters under varied conditions. I value such facts very highly, and attach great weight to them, and did these varieties occur only in New Zealand I should perhaps have withheld so strong an opinion on the subject; but such is not the case. *O. corniculata* varies as much in numerous other parts of the world; and admitting, as every one must, that varieties are known to retain their characters with more or less constancy for certain periods, some other evidence is necessary to shake the opinion of the botanist who grounds his views on an examination of the plant from all quarters of the globe.

‖ As no identification is proved till all the organs of the plants to be compared have been studied, there is yet a possibility of these three species proving distinct, but I do not at all expect it; the only difference I can find is a greater obliquity and emargination of the petals of the New Zealand species, but that character varies so much both in this plant and in others of the genus that it loses all specific value.

British Museum. When re-found in New Zealand it was described as new, and called *O. cataractæ*, and when found a third time in Tasmania, was called by still a third name, *O. lactea*. In this case a more important fact was smothered than that of the distribution of *O. corniculata*, namely, that of a very peculiar plant of the south temperate zone being common to these three widely sundered localities.

Many similar instances might be added, for there are several New Zealand plants (as *Pteris aquilina*) that have a different name in almost every country in the world, and, partly from changes in nomenclature, partly from the reduction of species, I have found myself obliged to quote 1500 names for the 720 New Zealand flowering-plants described, and I believe I might have doubled the number had my limits not obliged me to reduce the synonymy as much as possible; in many cases too much, I fear, for the requirements of working botanists in Europe.

## § 4.

*The distribution of species has been effected by natural causes, but these are not necessarily the same as those to which they are now exposed.*

Of all the branches of Botany there is none whose elucidation demands so much preparatory study, or so extensive an acquaintance with plants and their affinities, as that of their geographical distribution. Nothing is easier than to explain away all obscure phenomena of dispersion by several speculations on the origin of species, so plausible that the superficial naturalist may accept any of them; and to test their soundness demands a comprehensive knowledge of facts, which moreover run great risk of distortion in the hands of those who do not know the value of the evidence they afford. I have endeavoured to enumerate the principal facts that appear to militate against the probability of the same species having originated in more places (or centres) than one; but in so doing I have only partially met the strongest argument of all in favour of a plurality of centres, viz. the difficulty of otherwise accounting for the presence in two widely sundered localities of rare local species, whose seeds cannot have been transported from one to the other by natural causes now in operation. To take an instance: how does it happen that *Edwardsia grandiflora* inhabits both New Zealand and South America? or *Oxalis Magellanica* both these localities and Tasmania? The idea of transportation by aerial or oceanic currents cannot be entertained, as the seeds of neither could stand exposure to the salt water, and they are too heavy to be borne in the air. Were these the only plants common to these widely-sundered localities, the possibility of some exceptional mode of transport might be admitted by those disinclined to receive the doctrine of double centres; but the elucidation of the New Zealand Flora has brought up many similar instances equally difficult to account for, and has developed innumerable collateral phenomena of equal importance, though not of so evident appreciation. These, which all bear upon the same point, may be arranged as follows:—

1. Seventy-seven plants are common to the three great south temperate masses of land, Tasmania, New Zealand, and South America.

2. Comparatively few of these are universally distributed species, the greater part being peculiar to the south temperate zone.

3. There are upwards of 100 genera, subgenera, or other well-marked groups of plants entirely or nearly confined to New Zealand, Australia, and extra-tropical South America. These are represented by one or more species in two or more of these countries, and they thus effect a botanical relationship or affinity between them all, which every botanist appreciates.

4. These three peculiarities are shared by all the islands in the south temperate zone (including even Tristan d'Acunha, though placed so close to Africa), between which islands the transportation of seeds is even more unlikely than between the larger masses of land.

5. The plants of the Antarctic islands, which are equally natives of New Zealand, Tasmania, and Australia, are almost invariably found only on the lofty mountains of these countries.

Now as not only individual species, but groups of these, whether orders, genera, or their sub-divisions, are to a great degree distributed within certain limits or areas, it follows that the flora of every island or archipelago presents peculiarities of its own. Though an insular climate may favour the relative abundance of individuals, and even species of certain Natural Orders, there is nothing in the climate, or in any other attribute of insularity, which indicates the nature of the peculiarity of endemic species. The islands of each ocean contain certain botanically allied forms in common, which are more or less abundant in them, and rarely or never found on the neighbouring continents; thus there are curious genera peculiar to the North Atlantic islands, others to the North Pacific islands, others to those of the South Pacific, and others again to the Malayan Archipelago; just as there are still others peculiar to the Antarctic islands, and many to New Zealand, Fuegia, and Tasmania.

Each group of islands hence forms a botanical region, more or less definable by its plants as well as by its oceanic boundaries; precisely as a continuous area like Australia or South Africa does. There is however this difference, that whereas the Natural Orders that give a botanical character to a continuous area of a continent or to a large island (as the *Proteaceæ* in South Africa or in New Holland, and *Coprosma* in New Zealand) are numerous in species and often uniformly spread,—in clusters of small islands, distant from continents, they are few in species, and the individuals are scattered, appearing as if the vestiges of a flora which belonged to another epoch, and which is passing away: this is perhaps a fanciful idea, but one which I believe to contain the germ of truth; for no Botanist can reflect upon the destruction of peculiar species on small islands (such as is now going on in St. Helena amongst others), without feeling that, as each disappears, a gap remains, which may never be botanically refilled; that not only are those links breaking by which he connects the present flora with the past, but also those by which he binds the different members of the vegetable kingdom one to another. It is not true in every sense that all existing nature appears to the naturalist as an harmonious whole; each species combines by its own peculiarities two or more others more closely, and reveals their affinities more clearly, than any other does; just as the flora of an intermediate spot of land connects those of two adjacent areas better than any other locality does. It is often by one or a very few species that two large Natural Orders are seen to be related; just as by a few Chilian plants the whole flora of New Zealand is connected with that of South America. The destruction of a species must hence create an hiatus in our systems, and I believe that it is mainly through such losses that natural orders, genera, and species become isolated, that is, peculiar, in a naturalist's eyes.

To return to the distribution of existing species, I cannot think that those who, arguing for unlimited powers of migration in plants, think existing means ample for ubiquitous dispersion, sufficiently appreciate the difficulties in the way of the necessary transport. During my voyages amongst the Antarctic islands, I was led, by the constant recurrence of familiar plants in the most inaccessible spots, to reflect much on the subject of their possible transport; and the conviction was soon forced upon me, that, putting aside the almost insuperable obstacles to trans-oceanic migration between such islands as Fuegia and Kerguelen's Land, for instance (which have plants in common, not found elsewhere), there were such peculiarities in the plants so circumstanced, as rendered many of them the least likely of all to have availed themselves of what possible chances of transport there may have been. As species they were either not so abundant in individuals, or not prolific enough to have been the first to offer themselves for chance transport, or their seeds presented no facilities for migration*, or were singularly perishable from feeble vitality, soft or brittle integuments, the presence of oil that soon became rancid, or from having a fleshy albumen that quickly decayed†. Added to the fact that of all the plants in the respective floras of the Antarctic islands, those common to any two of them were the most unlikely of all to emigrate, and that there were plenty of species possessing unusual facilities, which had not availed themselves of them, there was another important point, namely, the little chance there was of the seeds growing at all, after transport. Though thousands of seeds are annually shed in those bleak regions, few indeed vegetate, and of these fewer still arrive at maturity. There is no annual plant in Kerguelen's Land, and seedlings are extremely rare there; the seeds, if not eaten by birds, either rot on the ground or are washed away; and the conclusion is evident, that if such mortality attends them in their own island, the chances must be small indeed for a solitary individual, after being transported perhaps thousands of miles, to some spot where the available soil is pre-occupied.

Beyond the bare fact of the difficulty of accounting by any other means for the presence of the same species in two of the islands, there appeared nothing in the botany of the Antarctic regions to support or even to favour the assumption of a double creation, and I hence dismissed it as a mere speculation which, till it gained some support on philosophical principles, could only be regarded as shelving a difficulty; whilst the unstable doctrine that would account for the creation of each species on each island by progressive development on the spot, was contradicted by every fact.

It was with these conclusions before me, that I was led to speculate on the possibility of the plants of the Southern Ocean being the remains of a flora that had once spread over a larger and more continuous tract of land than now exists in that ocean; and that the peculiar Antarctic genera and species may be the vestiges of a flora characterized by the predominance of plants which are now scattered throughout the southern islands. An allusion to these speculations was made in the 'Flora Antarctica' (pp. 210 and 368), where some circumstances connected with the distribution of the Antarctic islands were dwelt upon, and their resemblance to the summits of a submerged mountain chain was pointed out; but beyond the facts that the general features of the flora favoured such a view, that the difficulties in the way of transport appeared to admit of no other solution, and that there are no limits assignable to the age of the species that would make their creation posterior to such a series of geological changes as should remove the intervening land, there was nothing in the shape of evidence by which my speculation could be supported. I am indebted to the invaluable labours of Lyell and Darwin‡, for the facts that could alone have given countenance to such an hypothesis; the one showing that the necessary time and elevations and depressions of land

* Thus of the *Compositæ*, common to Lord Auckland's Group, Fuegia, and Kerguelen's Land, none have any pappus (or seed-down) at all! Of the many species *with* pappus, none are common to two of these islands!

† Of the seeds sent to England from the Antarctic regions, or transported by myself between the several islands, almost all perished during transmission.

‡ See Darwin's 'Journal of a Naturalist,' and 'Essays on Volcanic Islands and Coral Islands.' The proofs of the coasts of Chili and Patagonia having been raised continuously, for several hundred miles, to elevations varying between 400 and 1300 feet, since the period of the creation of existing shells, will be found in the first-named of these admirable works, which should be in the hands of every New Zealand Naturalist, if only from its containing

need not be denied; and the other, that such risings and sinkings are in active progress over large portions of the continents and islands of the southern hemisphere. It is to the works of Lyell* that I must refer for all the necessary data as to the influence of climate in directing the migration of plants and animals, and for the evidence of the changes of climate being dependent on geological change. In the 'Principles of Geology' these laws are proved to be of universal application, and amply illustrated by their being applied to the elucidation of difficult problems in geographical distribution. It follows from what is there shown, that a change in the relative positions of sea and land has occurred to such an extent since the creation of still existing species, that we have no right to assume that the plants and animals of two given areas, however isolated by ocean, may not have migrated over pre-existing land between them. This was illustrated by an examination of the natural history of Sicily (where land-shells, still existing in Italy, and which could not have crossed the Straits of Messina, are found imbedded on the flanks of Etna high above the sea-level), regarding which Sir Charles Lyell states that most of the plants and animals of that island are older than the mountains, plains, and rivers they now inhabit†.

It was reserved for Professor Edward Forbes, one of the most accomplished naturalists of his day, to extend and enlarge these views, and to illustrate by their means the natural history of an extensive area; which he did by applying a profound knowledge of geology and natural history to the materials he had collected during his arduous surveys of many of the shores of Europe and the Mediterranean. The result has been the enunciation of a theory, from which it follows that the greater part, if not all, of the animals and plants of the British Islands have immigrated at different periods, under very different climatic conditions; and that all have survived immense changes in the configuration of the land and seas of Northern Europe. The arguments which support this theory are based upon evidence derived from Zoology and Geology‡, and they receive addi-

important observations on his own islands. The fact of this accomplished Naturalist and Geologist having preceded me in the investigation of the Natural History of the Southern Ocean, has materially influenced and greatly furthered my progress; and I feel it the more necessary to mention this here, because Mr. Darwin not only directed my earliest studies in the subjects of the distribution and variation of species, but has discussed with me all the arguments, and drawn my attention to many of the facts which I have endeavoured to illustrate in this Essay. I know of no other way in which I can acknowledge the extent of my obligation to him, than by adding that I should never have taken up the subject in its present form, but for the advantages I have derived from his friendship and encouragement.

* To Sir Charles Lyell's works, indeed, I am indebted for the enunciation of those principles that are essential to the progress of every naturalist and geologist; those, I mean, that affect the creation and extinction, dispersion and subsequent isolation of organic beings; and though botanists still differ in opinion as to the views he entertains on the most speculative of subjects (the origin and permanence of species), there is, I think, but one as to the soundness and originality of his observations on all that relates to the strict dependence of organic beings on physical conditions in the state of the earth's surface. I feel that I cannot over-estimate the labours of this great philosopher, when I reflect that without them the science of geographical distribution would have been with me little beyond a tabulation of important facts; and that I am indebted to them, not only for having given a direction to my studies in this department, but for an example of admirable reasoning on the facts he has collected regarding the distribution of plants and animals. I have no hesitation in recommending the 'Principles of Geology' to the New Zealand student of Nature, as the most important work he can study.

† See the Principles of Geology, ed. 9. p. 702, and Address to the Geological Society of London by the President (Leonard Horner, Esq.), in 1847, p. 66.

‡ For the contents of the Essay itself, I must refer to the Records of the Geological Survey of Great Britain, vol. i. p. 336. This is the most original and able essay that has ever appeared on this subject, and though I cannot

tional weight from the fact that the distribution of British plants is in accordance with its principal features*.

The geographical distribution of British plants has been the subject of the most rigorous investigation by one of our ablest British botanists, Mr. H. C. Watson, who first drew attention to the various botanical elements of which the flora is composed, and grouped the species into botanical provinces. These provinces were intended for "showing the areas of plants, as facts in nature independent of all theoretical explanations and reasons." (Cybele Britannica, vol. i. p. 18.) An inspection of them shows the relations borne by the plants of England to those of certain parts of Europe and of the Arctic regions; and Professor Forbes, applying a modification of these botanical provinces to the illustration of his views of the original introduction of plants into the British Islands, proceeds to show that their migration took place at different periods, contemporary of course with the connection by land of each botanical region of Britain with that part of the continent which presents a similar association of plants.

To extend a theoretical application of these views to the New Zealand Flora, it is necessary to assume that there was at one time a land communication by which the Chilian plants were interchanged; that at the same or another epoch the Australian, at a third the Antarctic, and at a fourth the Pacific floras were added to the assemblage. It is not necessary to suppose that for this interchange there was a continuous connection between any two of these localities, for an intermediate land, peopled with some or all of the plants common to both, may have existed between New Zealand and Chili when neither of these countries was as yet above water†. To account, however, for the Antarctic plants on the lofty mountains, a new set of influences is demanded; no land connection between these islands and New Zealand could have effected this, for the climate of the intermediate area must necessarily have prevented it. But changes of relation between sea and land induce changes of climate, and the presence of a large continent connecting the Antarctic islands would, under certain circumstances, render New Zealand as cold as Britain was during the glacial epoch. Sir C. Lyell first demonstrated this, and showed what such conditions should be; and by consulting the 'Principles of Geology,' my reader will understand how such a climate would reign in the latitude of New Zealand, as that its flora should consist of what are now Antarctic forms of vegetation. The

subscribe to all its botanical details, I consider that the mode of reasoning adopted is sound, and of universal application. What I dissent from most strongly is, the origin of the gulf-weed; the peopling of Scotch mountains by iceberg transport of seeds, and the too great stress laid upon the west Irish flora, whose peculiarities appear to me to be considerably over-estimated.

* It may be well to state to the New Zealand student, that there are no reasons to suppose that Botany can ever be expected to give that direct proof of plants having survived geological changes of climate, sea, and land, which animals do; the cause is evident, for the bones of quadrupeds, shells of mollusca, and hard parts of many animals, afford an abundant means of specific identification, and such are preserved when the animals perish. In plants the case is widely different: their perishable organs of reproduction, which alone are available for systematic purposes, are seldom imbedded, even when other parts of the plants are.

† This disappearance of old land, and the migration of its flora and fauna to new, may be illustrated to a certain extent by the delta of any New Zealand river. A mud-bank on one shore, covered with mangroves, advances across the channel, the mangroves growing on the new land as it forms. The current changes, and the end of the bank (with its mangroves) is cut off, and becomes an island: another change of the river channel fills up that between the islet and the opposite shore, to which it hence becomes a peninsula, peopled by mangroves, whose parents grew on the opposite bank. Here, be it remarked, no subsidence is required, such as must have operated in the assumed isolation of New Zealand.

retirement of the plants to the summit of the New Zealand mountains*, would be the necessary consequence of the amelioration of climate that followed the isolation of New Zealand, and the replacement of the Antarctic continent by the present ocean.

The climate throughout the south temperate zone is so equable, and the isothermal lines are so parallel to those of latitude, that it is not easy for the New Zealand naturalist to realize the altered circumstances that would render the plains of his island suitable for the growth of plants that now inhabit its mountains only†; but if he glance at the map of the isothermal lines of the northern hemisphere, he will see how varied are the climates of regions in the same latitude; that London, with a mean temperature of 51°, is in the same latitude as Hudson's Bay, where the mean temperature is 30°, and the soil ever frozen: and he will further be able to understand by a little reflection, how a change in the relative positions of sea and land would, by isolating Labrador, raise its temperature 10°–15°, causing the destruction of all the native plants that did not retire to its mountain-tops, and favouring the immigration of the species of a more genial climate.

The first inference from such an hypothesis is that the Alpine plants of New Zealand, having survived the greatest changes, are its most ancient colonists; and it is a most important one in many respects, but especially when considered with reference to the mountain floras of the Pacific and southern hemisphere generally. These may be classed under three heads‡:—

1. Those that contain identical or representative species of the Antarctic Flora, and none that are peculiarly Arctic; as the Tasmanian and New Zealand Alps§.

2. Those that contain, besides these, peculiarities of the Northern and Arctic Floras||; as the South American Alps.

3. Those that contain the peculiarities of neither; as the mountains of South Africa and the Pacific Islands.

* With regard to the British mountains, Professor Forbes imagines that they were islets in the glacial ocean, and received their plants by transportation of seeds with soil, on ice from the Arctic regions. This appears to me to want support, and there is much in the distribution of Arctic plants especially, wholly opposed to the idea of ice transport being an active agent in dispersion. A lowering of 10° of mean temperature would render the greater part of Britain suitable to the growth of Arctic plants; it would give it the climate of Labrador, situated in the same latitude on the opposite side of the Atlantic. Britain is the warmest spot in its latitude, and a very slight geological change would lower its mean temperature many degrees.

† The New Zealand naturalist has probably a very simple means of determining for himself whether his island has been subject to a geologically recent amelioration of climate; to do which, let him examine the fiord-like bays of the west coast of the Middle Island, for evidence of the glaciers which there exist in the mountains having formerly descended lower than they now do. Glaciers to this day descend to the level of the sea in South Chili, at the latitude of Dusky Bay; and if they have done so in the latter locality, they will have left memorials, in the shape of boulders, moraines, and scratched and polished rocks.

‡ I need scarcely remind my reader that in thus sketching the characteristics of these Alpine floras, I make no allusion to exceptions that do not alter the main features. I am far from asserting that there are no peculiar Arctic or Antarctic forms in the Pacific Islands, nor any peculiarly Arctic ones in Tasmania and New Zealand: but if, on the one hand, future discoveries of such shall weaken the points of difference between these three mountain regions, on the other they might be very much strengthened by adducing the number of Arctic species common to the South American Alps, but not found in the others.

§ These Antarctic forms are very numerous; familiar ones are *Acæna, Drapetes, Donatia, Gunnera, Oreomyrrhis, Lagenophora, Forstera, Ourisia, Fagus, Callixene, Astelia, Gaimardia, Alepyrum, Oreobolus, Carpha, Uncinia.*

|| *Berberis, Sisymbrium, Thlaspi, Arabis, Draba, Sagina, Lychnis, Cerastium, Fragaria, Lathyrus, Vicia, Hippuris, Chrysosplenium, Ribes, Saxifraga, Valeriana, Aster, Hieracium, Stachys, Primula, Anagallis, Pinguicula, Statice, Empetrum, Phleum, Elymus, Hordeum.*

We thus observe that the want of an Arctic or Antarctic Flora at all in the Pacific islands, and the presence of an Arctic one in the American Alps, are the prominent features; and I shall confine my remarks upon these to the fact that, with regard to the isolated islands of the Pacific, they are situated in too warm a latitude to have had their temperature cooled by changes in the relative position of land and ocean, so as to have harboured an Antarctic vegetation. With regard to the South American Alps, there is direct land communication along the Andes from Arctic to Antarctic regions; by which not only may the strictly Arctic genera and species have migrated to Cape Horn, but by which many Antarctic ones may have advanced northward to the equator*.

There is still another point in connection with the subject of the relative antiquity of plants, and in adducing it I must again refer to the 'Principles of Geology,' where it is said, "As a general rule, species common to many distant provinces, or those now found to inhabit many distant parts of the globe, are to be regarded as the most ancient . . . . their wide diffusion shows that they have had a long time to spread themselves, and have been able to survive many important changes in Physical Geography†." If this be true, it follows that, consistently with the theory of the antiquity of the Alpine flora of New Zealand, we should find amongst the plants common to New Zealand and the Antarctic islands, some of the most cosmopolitan; and we do so in *Montia fontana, Callitriche verna, Cardamine hirsuta, Epilobium tetragonum,* and many others.

On the other hand, it must be recollected that there are other causes besides antiquity and facility for migration, that determine the distribution of plants; these are their power, mentioned above, of invading and effecting a settlement in a country preoccupied with its own species, and their adaptability to various climates: with regard to the first of these points, it is of more importance than is generally assumed, and I have alluded to its effects under *Sonchus,* in the body of this work. As regards climates, the plants mentioned above seem wonderfully indifferent to its effects‡.

Again, even though we may safely pronounce most species of ubiquitous plants to have outlived many geological changes, we may not reverse the position, and assume local species to be amongst the most recently created; for whether (as has been conjectured) species, like individuals, die out in the course of time, following some inscrutable law whose operations we have not yet traced, or whether (as in some instances we know to be the case) they are destroyed by natural causes (geological or others), they must in either case become scarce and local while they are in process of disappearance.

In the above speculative review of some of the causes which appear to affect the life and range of species in the vegetable kingdom, I have not touched upon one point, namely, that which concerns the original introduction of existing species of plants upon the earth. I have assumed that they have existed for ages in the forms they now retain, that assumption agreeing, in my opinion, with the facts elicited by a survey of all the phenomena they present, and, according to the most eminent zoolo-

* Why these Antarctic forms have not extended into North America, as the Arctic ones have into South America, is a curious problem, and the only hypothesis that suggests itself is derived from the fact that though the Panama Andes are not now sufficiently lofty for the transit of either, there is nothing to contradict the supposition that they may have had sufficient altitude at a former period, and that one which preceded the advance of the Antarctic species to so high a northern latitude.

† Principles of Geology, ed. 9. p. 702.

‡ Mr. Watson (Cybele Britannica) gives the range of *Callitriche* in Britain alone as including mean temperatures of 40° to 52°, and as ascending from the level of the sea to nearly 2000 feet in the East Highlands of Scotland. *Montia,* according to the same authority, enjoys a range of 36° to 52°, and ascends to 3300 feet; *Epilobium,* a temperature of 40° to 51°, and ascends to 2000 feet; *Cardamine,* a temperature of 37° to 52°, and ascends to 3000 feet.

gists, with those laws that govern animal life also; but there is nothing in what is assumed above, in favour of the antiquity of species and their wide distribution, that is inconsistent with any theory of their origin that the speculator may adopt. My object has not so much been to ascertain what may, or may not, have been the original condition of species, as to show that, granting more scope for variation than is generally allowed, still there are no unassailable grounds for concluding that they now vary so as to obliterate specific character; in other words, I have endeavoured to show that they are, for all practical purposes of progress in botanical science, to be regarded as permanently distinct creations, which have survived great geological changes, and which will either die out, or be destroyed, with their distinctive marks unchanged. We have direct evidence of the impoverishment of the flora of the globe, in the extinction of many most peculiar insular species within the last century; but whether the balance of nature is kept up by the consequent increase of the remainder in individuals, or by the sudden creation of new ones, does not appear, nor have we any means of knowing: if the expression of an opinion be insisted on, I should be induced to follow the example of an eminent astronomer, who, when the question was put to him, as to whether the planets are inhabited, replied that the earth was so, and left his querist to argue from analogy. So with regard to species, we know that they perish suddenly or gradually, without varying into other forms to take their place as species, from which established premiss the speculator may draw his own conclusions.

And now that I have brought these desultory observations to a close, I cannot review them without fearing that I may incur the charges of, on the one hand, attempting to promote a spirit of theoretical inquiry amongst those naturalists of the distant colony whom I would fain instruct; and on the other, of giving way to it myself, and occupying the time of my readers with what is with too many the foundation of fruitless controversy. In answer to the first I would say, that the speculations which I have endeavoured to combat are becoming widely spread amongst superficial observers, and are quoted every day as objections to the devotion of time and labour to a systematic inquiry into any branch of Natural History. The very many aspirants to a knowledge of science whom I have had the pleasure of knowing in the Colonies, though well educated in the ordinary acceptation of the term, have never been trained to habits of observation, or of reasoning upon what they read in the book of nature, nor have they been grounded in the elements of natural science; they are hence prone to rely for information on these speculative subjects (which they seek with avidity) upon a class of works that are, with very few exceptions, by authors who have no practical acquaintance with the sciences they write about, or with the facts they so often distort. I have further had a more practical object in view—the offering of theoretical reasons for inculcating caution on the future botanists of New Zealand; I have endeavoured to make it clear to those who may read these remarks, that systematic botany is a far more difficult and important object than is generally supposed; that the progress the student will make himself, and hence that the science will make in his country, is not to be measured by the number of new species he may find, but by his manner of treating the old, and his desire to regard all as parts of the vegetable kingdom, and not of the New Zealand Flora only; and that there is no surer sign of his not appreciating the aim and scope of the science he cultivates, than a craving to load it with names, and to take contracted views of species, their variation and distribution.

To those who may accuse me of giving way to hasty generalization or loose speculation on the antiquity and dispersion of plants over parts of the Southern Hemisphere, I may answer, that no speculation is idle or fruitless, that is not opposed to truth or to probability, and which, whilst it co-ordinates a body of well established facts, does so without violence to nature, and with a due regard to the possible results of future discoveries. I may add, that after twelve years' devotion to the laborious accumulation and arrangement of facts in the field and closet, untrammelled by any theories to combat or vindicate, I have thought that I might bring forward the conclusions to which my studies have led me, with less chance of incurring such a reproach, than those would, who, with far better abilities and judgment, have not had my experience and opportunities.

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## CHAPTER III.

### § 1. ON THE PHYSIOGNOMY AND AFFINITIES OF THE NEW ZEALAND FLORA.

In the following remarks, the flowering plants alone of New Zealand are referred to, except when it is otherwise stated: my object being primarily to show the relation between the botany of New Zealand and that of the south temperate continents, I have, for several reasons, considered that the introduction of the Ferns even was not expedient:—1. Because they include only one family of *Cryptogamia*, and that the only one towards a knowledge of whose number and distribution in New Zealand we have even approximately accurate data.—2. Because the diffusion of their minute spores is so ubiquitous*, and their growth is so dependent on one climatic element, viz. humidity, that their geographic distribution does not harmonize with that of flowering plants in general.

The traveller from whatever country, on arriving in New Zealand, finds himself surrounded by a vegetation that is almost wholly new to him; with little that is at first sight striking, except the Tree-fern and *Cordyline* of the northern parts, and nothing familiar, except possibly the Mangrove; and as he extends his investigations into the Flora, with the exception of *Pomaderris* and *Leptospermum*, he finds few forms that remind him of other countries. Of the numerous Pines, very few recall by habit and appearance the idea attached either to trees of this family in the northern hemisphere, or to the *Callitris* of New Holland, or to the *Araucariæ* of that country and Norfolk Island; while of the families that on examination indicate the only close affinity between the New Zealand Flora and that of any other country, (the *Myrtaceæ*, *Epacrideæ*, and *Proteaceæ*,) few resemble in general aspect

* A most remarkable exemplification of this is found in the occurrence of *Lycopodium cernuum* (a most universally distributed Fern in all warm climates) in the Azores, where it grows only around some hot springs. Within the last few months it has been also collected in St. Paul's Island (lat. 38° south), by the naturalists of Captain Denham's Expedition to the Pacific Islands: there, too, only where the ground is much heated by springs. These facts are most remarkable, for the *Lycopodium cernuum* does not inhabit Madeira or any spot in the Azores, except the vicinity of the hot springs, and St. Paul's Island is also far beyond its natural isothermal in that longitude of the southern hemisphere; and it is to be remarked, that in neither island is the *Lycopodium* accompanied by any other tropical plant, which would indicate the aerial transport of larger objects than the microscopic spores of *Lycopodia*, which are raised in clouds from large surfaces covered with the gregarious species.

their allies in Australia. A paucity of Grasses, an absence of *Leguminosæ,* an abundance of bushes and Ferns, and a want of annual plants, are the prevalent features in the open country, whilst the forests abound in *Cryptogamia,* and in phænogamic plants with obscure green flowers, and very often of obscure and little-known Natural Orders*.

Considerably more than two hundred of the New Zealand species have either unisexual or polygamous flowers, or are otherwise incomplete in their reproductive organs, even when their floral envelopes are more or less developed. The number of Natural Orders† is large in proportion to the genera; being as 92 to 282, that is, about one to three: while the genera are to the species as 282 to 730, each genus having on the average only two and a half species; whence it follows that there are, on the average, but eight species to each Natural Order.

Considering these circumstances, and the additional one, that very many of the Natural Orders cannot be recognized by the flower alone, by fruit alone, or by habit or foliage, it may, I think, safely be said that the New Zealand Flora is, for its extent, much the most difficult on the globe to a beginner. Indeed, the mere fact that the student must know a Natural Order for every eight species he has to investigate, offers as direct a means of proving this by comparison as any datum could do, for the probable proportion of species of plants on the globe to the known Natural Orders, exceeds three hundred and fifty to one; in Tasmania the proportions are eleven to one, and in Great Britain they average fourteen to one.

It is, therefore, not surprising that the vegetation of New Zealand should be wanting in any conspicuous or prevailing feature, which is the case to so great a degree that, excluding Ferns, I do not think any two botanists would, without investigation, characterize any part of the islands as the region of any particular order, genus, or species. The *Coniferæ,* when known, prove to be perhaps the most universally prevalent natural family; but the majority of their species, not being social, but growing intermixed with other trees, give no character to the landscape. The vast number of trees, the paucity of herbaceous plants, and the almost total absence of annuals, are the most remarkable features of the Flora; for of flowering trees, including shrubs above twenty feet high, there are upwards of 113‡, or nearly one-sixth of the Flora, besides 156 shrubs and plants with woody stems. Of the largest Natural Orders, so far as regards the number of species, the individuals are often so few, that the botanist would form a very erroneous estimate of the numerical force of such in the whole island from an examination of some of its parts only: thus the Orders most numerous in species are, *Compositæ,* 90; *Cyperaceæ,* 66; *Gramineæ,* 53; *Scrophularineæ,* 40; *Orchideæ,* 39; *Rubiaceæ,* 26; and *Epacrideæ* and *Umbelliferæ,* each 23; none of which can be said to form prevalent features in the landscape, though none are rare.

In the neighbouring island of Tasmania, where the same Orders predominate to a great extent, the case is widely different: there the Grasses everywhere form a prominent feature; the *Cyperaceæ,*

* My first day's collections about the Bay of Islands included *Corynocarpus, Alseuosmia, Melicytus, Drimys, Aristotelia, Coriaria, Gunnera, Carpodetus, Griselinia, Corokia, Geniostoma, Laurelia, Hedycarya, Freycinetia, Rhipogonum,* and *Astelia;* all belonging to small, obscure, or little-known Natural Orders, many long considered of dubious affinity: besides a host of obscure genera of little-known families.

† It is to be observed, that I have adopted as few Natural Orders as possible; fewer, I think, than I should have done in a work on general botany; but I was anxious to diminish as much as possible the labours of the beginner. Had I adopted all the Orders that have been proposed, there would be upwards of a hundred of flowering plants in New Zealand.

‡ In England there are not more than 35 native trees, out of a flora of upwards of 1400 species.

from their size, strength, and cutting foliage, arrest the traveller's progress through the forest; *Orchideæ* of many kinds carpet the ground in spring with beautiful blossoms; the heaths are gay with *Epacrideæ;* herbs, trees, and shrubs of *Compositæ* meet the eye in every direction; whilst the *Myrtaceæ* and *Leguminosæ* are characteristics both of the arboreous and shrubby vegetation. The difference is so marked, that I retain the most vivid recollection of the physiognomy of the Tasmanian mountains and valleys, but a very indifferent one of the New Zealand forest, where all is, comparatively speaking, blended into one green mass, relieved at the Bay of Islands by the symmetrical crown of the Tree-fern, the pale green fountain of foliage of the *Dacrydium cupressinum,* and the poplar-like *Knightia* overtopping all. It is true that there is more variety in the latter country than is expressed by this selection of a few individuals, and a little reflection recalls a vast number of noble, and some beautiful botanical objects, but with the exception of groves of the Kaikatea Pine (*Podocarpus dacrydioides*) on the swampy river banks, the *Pomaderris* and *Leptospermum* on the open hill-sides, and *Dammara* on their crests, there is little to arrest the botanist's first glance; and nothing in the massing or grouping of the species of any Natural Order renders that Order an important element in the general landscape, or gives individuality to any of its parts, by flowers and gaiety, or by foliage and gloom. The same features prevail even so far south as Lord Auckland's Group, where *Dracophyllum, Coprosma, Metrosideros, Panax,* and a shrubby *Veronica* unite to form an evergreen mantle: and I suspect, from the accounts I have heard and read, that they are repeated on the damp cool coasts of Chili, to the north of the region of the sombre Beech-forests which clothe the Fuegian islands.

### A. *Plants peculiar to New Zealand.*

In analysing the Phænogamic Flora of New Zealand, the first important result is the large amount of absolutely peculiar or endemic plants, of which there are 26 genera and 507 species, or more than two-thirds of the whole. Of these, the greater proportion are Exogens, as was to be expected, from the Grasses, *Cyperaceæ,* and water-plants being more widely diffused than any other families.

The Petaloid Endogens, on the other hand, are remarkably local, especially the *Orchideæ,* of which only two species, out of thirty-nine, are found elsewhere (in Tasmania). This, however, is so invariably the case with *Orchideæ,* that the proportion of species in the globe to other Natural Orders is perhaps greatly underrated. Nearly all the New Zealand genera of Orchids are natives of Australia, and most of them are otherwise peculiar to that continent; the ubiquitous *Spiranthes* is the most marked exception, as Australia contains the only widely distributed species in that vast Natural Order, namely, *S. rosea,* which however is replaced in New Zealand by *S. Novæ-Zelandiæ.*

The next peculiar Order is *Coniferæ,* whose twelve species are all endemic*: it is very widely spread, and many of its species in the northern hemisphere have wide though strictly defined ranges. In this respect the southern species differ from the northern, for they are local; thus several occupy very limited areas indeed in Tasmania and elsewhere, of which the Huon and Norfolk Island Pines are remarkable instances: *Dammara australis* is confined to the northern half of the northern island of New Zealand, and other species only grow on a few lofty mountains. Of the New Zealand genera, two are peculiar to it, Australia, and the Malay Archipelago (*Dacrydium* and *Phyllocladus*);

* Except perhaps *Phyllocladus,* one species of which is very closely allied to the Tasmanian *P. asp*[illegible]

*Dammara* is common to New Zealand, the Moluccas, and New Caledonia; *Podocarpus* is found in many parts of the world from Japan to the Straits of Magellan, from India to Tasmania and South Africa; but *Thuja* is absent from Australia, though found in most countries inhabited by *Podocarpus*, and in rather high northern latitudes of western North America. Several of the *Coniferæ* of New Zealand are alpine, as are others in many parts of the world. The absence of the whole Order in the Atlantic, in the smaller, remote, Antarctic and Pacific Islands, is one of the most curious features in its distribution and in their botany, for *Coniferæ* ascend the loftiest mountains of New Zealand and Tasmania.

*Scrophularineæ* includes many of the endemic species, thirty-three out of the forty being so. Of these, one of the two *Calceolarias* is very closely allied to a Chilian species; these and the *Mimuli*, a shrubby *Veronica*, and *Ourisia* further intimately connect the Flora with that of South America, as do other species of *Veronica, Mimulus, Ourisia*, and *Euphrasia* with that of Tasmania.

The *Epacrideæ* all belong to Australian genera, and two are species of that continent and of Tasmania.

Of *Compositæ* upwards of seventy-four are endemic, an enormous proportion, considering how fugitive their seeds are, and that the genera are almost without exception Australian. *Araliaceæ* are all peculiar, as are the greater number of *Umbelliferæ*, and all the *Myrtaceæ*, with one exception (a New Holland species), and all but four of the *Ranunculaceæ*.

A close botanical relationship to other countries may thus be traced in most of the endemic genera and species. The exceptional genera are *Ixerba*, which belongs to a Madagascar family (*Brexiaceæ*); *Corynocarpus*, which I have reduced to *Terebinthaceæ*; *Carpodetus*, also of disputed affinity, which I place in *Escalloniæ*, and which is one of the few extra South American species of that Order, which is considered by some to be a tribe of *Saxifrageæ*; *Griselinia* and *Corokia*, which I think both belong to *Corneæ*, and which are also more nearly allied to some South American plants than to any others; *Alseuosmia* has no near known affinity; *Phormium*, which appears "sui generis," is elsewhere found only in Norfolk Island; *Nesodaphne*, one of the two genera of *Laurineæ*, is allied to a South American genus.

### B. *Plants common to New Zealand and other Countries.*

The remaining third of the New Zealand Flora may be divided into five groups, for illustrating the relations of the plants to those of other countries,—viz.,

1. 193 species, or nearly one-fourth of the whole, are Australian.
2. 89 species, or nearly one-eighth of the whole, are South American.
3. 77 species, or nearly one-tenth of the whole, are common to both the above.
4. 60 species, or nearly one-twelfth of the whole, are European.
5. 50 species, or nearly one-sixteenth of the whole, are Antarctic Islands', Fuegian, etc.

1. *Those of Australian affinity*.—The decided preponderance of Australian forms is not confined to this large number of absolutely identical species; I have shown it to prevail in the genera containing peculiar species also. There are no Natural Orders in New Zealand which are not also found in Australia and Tasmania, except *Coriariæ, Escalloniæ, Brexiaceæ*, and *Chloranthaceæ*. Upwards of 240 of the 282 New Zealand genera are Australian, and of these more than fifty are all but confined to these two countries. New Zealand, however, does not appear wholly as a satellite of Australia in all the genera common to both, for of several there are but few species in

Australia, which hence shares the peculiarities of New Zealand, rather than New Zealand those of Australia: this is the case with *Pittosporum, Coprosma, Olearia, Celmisia, Forstera, Gaultheria, Dracophyllum, Veronica, Fagus, Dacrydium,* and *Uncinia;* of which there are comparatively few species in Australia and Tasmania: on the other hand, *Stackhousieæ, Pomaderris, Leptospermum, Exocarpus, Persoonia, Epacris, Leucopogon, Goodenia,* and a few other large Australian genera, are very scantily represented in New Zealand.

If the number of plants common to Australia and New Zealand is great, and quite unaccountable for by transport, the absence of certain very extensive groups of the former country is still more incompatible with the theory of extensive migration by oceanic or aerial currents. This absence is most conspicuous in the case of *Eucalypti,* and almost every other genus of *Myrtaceæ,* of the whole immense genus of *Acacia,* and of its numerous Australian congeners, with the single exception of *Clianthus,* of which there are but two known species, one in Australia, and the other in New Zealand and Norfolk Island.

The rarity of *Proteaceæ, Rutaceæ,* and *Stylideæ,* and the absence of *Casuarina* and *Callitris,* of any *Goodeniæ* but *G. littoralis* (equally found in South America), of *Tremandreæ, Dilleniaceæ,* and of various genera of *Monocotyledones,* admit of no explanation, consistent with migration over water having introduced more than a very few of the plants common to these tracts of land. Considering that *Eucalypti* form the most prevalent forest feature over the greater part of South and East Australia, rivalled by the *Leguminosæ* alone, and that both these Orders (the latter especially) are admirably adapted constitutionally for transport, and that the species are not particularly local or scarce, and grow well wherever sown, the fact of their absence from New Zealand cannot be too strongly pressed on the attention of the botanical geographer, for it is the main cause of the difference between the floras of these two great masses of land being much greater than that between any two equally large contiguous ones on the face of the globe. If no theory of transport will account for these facts, still less will any of variation; for of the three genera of *Leguminosæ* which do inhabit New Zealand, none favour such a theory; one, *Clianthus,* I have just mentioned; the second, *Edwardsia,* consists of one tree, identical with a Juan Fernandez and Chilian one, and unknown in New Holland; and the third genus (*Carmichælia*) is quite peculiar, and consists of a few species feebly allied to some New Holland plants, but exceedingly different in structure from any of that extensive Natural Order.

2. *Species of South American affinity.*—The South American species in New Zealand amount to 89, or one-eighth: of these some are absolutely peculiar to the two countries, as *Myosurus aristatus,* two species of *Coriaria, Edwardsia grandiflora, Haloragis alata, Hydrocotyle Americana,* and *Veronica elliptica.* Of these the *Edwardsia* is by far the most striking case, from the size of the tree: it appears to have a much wider range in New Zealand than in Chili, and supposing it to have been transported between these countries, it is difficult to say which was the parent one; its affinities would, however, incline us to consider it amongst the aborigines of the former. It is by representative genera and species that the affinity of the New Zealand and South American floras is best shown, and this most conspicuously by *Fuchsia* and *Calceolaria,* two most remarkable genera, confined to these two countries, but by far the most abundant to the west of the Andes. Here again the amount of affinity is differently displayed by each; of the Calceolarias one is so closely allied to an American species, that I doubt the propriety of keeping them separate, while the other appears a very distinct species; the Fuchsias are both extremely peculiar, one of them being the only species that has no petals. Altogether there are 76 genera common to New Zealand and South America.

and 17 of these are not found in Australia, or elsewhere in the Old World. It is curious that none of the latter belong to those peculiarly Arctic and north temperate genera mentioned in the note to p. xxiv, except *Caltha*, to a southern form of which, however, the New Zealand species belongs.

3. *Plants common to New Zealand, Australia, and South America.*—Of the 77 plants common to these three countries, which include one-tenth of the flora of New Zealand, the majority are Grasses, 10; *Cyperaceæ*, 7; moisture-loving Monocotyledons, 9; *Monochlamydeæ*, 8; *Umbelliferæ* and *Compositæ* each 4; and fully 50 of the whole number are also found in Europe, and do not indicate any peculiar affinity between these three southern masses of land: of those that are not European, some are Antarctic plants found in mountainous districts of Australia and Tasmania, as *Oxalis Magellanica*. Of genera and species which, from their near affinity with one another, and marked distinction from any others, may be said to be represented in all three countries, the majority are Antarctic, and will be noticed under the fifth head.

4. *European plants in New Zealand.*—These, amounting to 60, or about one-twelfth of the whole flora, are in many respects the most interesting, and to their identification (which I consider approximate only) I have given a great deal of care. Many I consider still open to inquiry, which may reduce their supposed numbers; but on the other hand I am sure that future discoveries will add to them. To some extent these are distributed according to well-defined laws, which do accord with facilities for migration by transport, thus:—*a*. 17 are sea-shore plants, or inhabitants of salt marshes, as *Ruppia, Zannichellia, Atriplex,* and their allies; *Dodonæa, Arenaria rubra,* and *Calystegia Soldanella,* also affect coasts;—*b*. 16 are fresh-water plants, or natives of very marshy spots, for whose transport, however, it appears to me as difficult to account as if they were land-plants;—*c*. 5 are *Compositæ*, of which four have pappus; a facility for aerial transport, which loses its significance and weight from the fact that the species of *Compositæ* (which of all Orders is the largest and most universal) are the most local. The fact of these five being found in so very many parts of the globe, and being the only ones that are so, is extremely remarkable, for it points to oceanic transport as the means of their diffusion: though the probabilities are against their all having thus accidentally met in that most isolated area which they all inhabit;—*d*. 19 of the species are *Glumaceæ*, including seven Grasses and three aquatic *Cyperaceæ* (which latter have also been included under *b*).

This large proportion of the lower Orders of Phænogamic plants is in accordance with a general law of geographic distribution, but not the more intelligible on that account, for I cannot recognize in their structure or physiology any peculiarities that render them fitted for such diffusion*. And I may add, that after a most careful microscopic study of the structure of the seeds of all the plants common to Europe and New Zealand, I have come to the conclusion that, as a body, they present no such facility for trans-oceanic or aerial transport, as would account for their having migrated further than the majority of other plants. To this may be added the fact that the Orders to which they belong, are not those whose seeds after transport are found to vegetate most surely or freely in gardens.

Many of the European species occurring in New Zealand are also Australian, Tasmanian, and Antarctic; some of the more remarkable exceptions are,—of plants not hitherto found in South America, *Hierochloe borealis, Alopecurus geniculatus,* some *Carices,* and other Monocotyledons. Of plants not found in Australia, *Agrostis canina* and *Taraxacum officinale.* Of those not found either in Australia or South America, *Carex stellulata* and *Pyrenaica,* and *Sparganium natans.*

* For some details upon the adaptation of various seeds to oceanic and aerial transport, see my Essay on the Geographic Distribution of the Plants in the Galapagos Archipelago.—Transactions of the Linnean Society, vol. xx.

It should also be mentioned here, that some very widely diffused European and Australian plants are absent from New Zealand, as *Lythrum Salicaria, Alchemilla arvensis, Portulaca oleracea, Hydrocotyle vulgaris, Zapania nodiflora, Verbena officinalis, Prunella vulgaris, Samolus Valerandi, Vallisneria spiralis, Potamogeton perfoliatus* and *crispus, Alisma Plantago, Caulinia oceanica, Juncus maritimus* and *effusus, Carex cæspitosa, Cladium Mariscus, Isolepis fluitans, Cyperus rotundus, Glyceria fluitans,* and *Arundo Phragmites.*

5. *Antarctic* plants in New Zealand.*—Of these Antarctic plants, about 50 inhabit the mountains and southern extreme of New Zealand; a number which (as I have stated at p. 15) will probably be greatly increased by future discoveries. They may be geographically grouped as follows:—*a.* Those of general distribution, being common also to Europe, as *Callitriche, Montia, Cardamine hirsuta, Potentilla anserina, Epilobium tetragonum, Myriophyllum, Calystegia Soldanella* and *C. Sepium, Limosella,* many *Monochlamydeæ,* and more *Monocotyledones.*—*b.* Those found also in Tasmania†, and chiefly on its mountains, but not elsewhere; as *Oxalis Magellanica, Acæna,* some *Epilobia, Colobanthus, Scleranthus, Tillæa, Apium, Coprosma, Leptinella, Hierochloe antarctica,* etc.

The botanical affinity between extra-tropical South America, the Antarctic islands, New Zealand, and Tasmania, is, however, much better indicated by the peculiar genera, by groups of those, or by individual species which, as it were, represent one another in two or more of these localities, and which give a peculiar botanical character to the flora of southern latitudes beyond latitude 35°.

Of these genera, there are 50 which afford botanical characters in common, and give as decided a proof of close affinity in vegetation, as do the 50 identical species above mentioned. The most conspicuous of these genera common to all the above-named localities are, *Colobanthus, Drosera, Acæna, Gunnera, Oreomyrrhis, Leptinella, Lagenophora, Forstera, Pratia, Gaultheria, Gentiana, Euphrasia, Plantago, Drapetes, Fagus, Astelia, Juncus, Carpha, Chætospora, Oreobolus, Uncinia, Carex,* and many Grasses, especially *Hierochloe, Alopecurus, Trisetum, Deyeuxia,* etc.

In the following list 228 species are thus contrasted: in most of these cases the parallelism is very striking, but a few are open to future investigation. In sketching out the grand features of so large an area, I must demand some indulgence from those of my readers who may have the opportunity of going into the details of the evidence I here adduce. The subject is one that cannot be fully worked out without far more materials than have hitherto been collected. I could easily have trebled the list were there any object in doing so, by adducing instances of feebler representation‡ than I have thought it worth while to introduce. When the floras of the mountains of South Chili, New Zealand, Southern Tasmania, the Australian Alps, the Crozets, Prince Edward's Islands, Amsterdam Island, St. Paul's Island, and M'Quarrie Island, shall have been properly explored, the great problem of Representation and Distribution in the South Temperate and Antarctic zone will be solved.

* For the limitation of the term Antarctic, I must refer to the Introduction to the second part of the 'Flora Antarctica,' p. 210, and shall only mention here that its flora includes that of Fuegia, the Falklands, with different islands east and south of them, Tristan d'Acunha, St. Paul's, Amsterdam and Kerguelen's Land, Lord Auckland's, Campbell's, and other islands south and east of New Zealand.

† Tasmania contains some Antarctic genera and species not hitherto found in New Zealand, which will be specially alluded to in the Tasmanian Flora, as *Pernettya, Eucryphia,* etc.

‡ I need hardly remark, that in the following list all the instances selected are of Botanical affinity; to the exclusion of cases of mere analogical resemblance between plants that are not botanically closely allied.

*Comparative table of plants which may be considered as representing one another (more or less remarkably) in two or all the three south temperate masses of land, viz. New Zealand (including Auckland and Campbell's Island), Australia (including Tasmania), and extra-tropical South America (including the Falkland Islands).*

| NEW ZEALAND, ETC. | AUSTRALIA AND TASMANIA. | TEMPERATE AND COLD S. AMERICA. |
|---|---|---|
| Ranunculus *subscaposus*, H.f. | Ranunculus *lappaceus*, Sm. | Ranunculus *Chilensis*, DC. |
| Caltha *Novæ-Zelandiæ*, H.f. | | Caltha *sagittata*, Cav. |
| Drimys *axillaris*, Forst. | Tasmannia *aromatica*, Br. | Drimys *Winteri*, Forst. |
| Lepidium *oleraceum*, Forst. | Lepidium *Piscidium*, Forst. | |
| Drosera *stenopetala*, H.f. | Drosera *Arcturi*, Hook. | Drosera *uniflora*, Willd. |
| | Eucryphia *Billardieri*, Spach. | Eucryphia *cordifolia*, Cav. |
| Hymenanthera *crassifolia*, H.f. | Hymenanthera *angustifolia*, Br. | |
| Colobanthus *Billardieri*, Fenzl. | Colobanthus *Billardieri*, Fenzl. | Colobanthus *crassifolius*, H.f. |
| Linum *monogynum*, Forst. | Linum *marginatum*, A. C. | |
| Aristotelia *racemosa*, H.f. | Friesia *peduncularis*, DC. | Aristotelia *Macqui*, Hérit. |
| Plagianthus *sidoides*, Hook. | Plagianthus *urticinus*, A. C. | |
| Discaria *Australis*, Hook. | Discaria *Australis*, Hook. | Colletia *discolor*, Hook. |
| Stackhousia *minima*, H.f. | Stackhousia *flava*, H.f. | |
| Geum *Magellanicum*, Com. | Geum *urbanum*, L. ? | Geum *Magellanicum*, Com. |
| Rubus *Australis*, Forst. | Rubus *Gunnianus*, Hook. | Rubus *geoides*, Sm. |
| Acæna *sanguisorbæ*, Vahl. | Acæna *sanguisorbæ*, Vahl. | Acæna *lævigata*, Ait. |
| Fuchsia *excorticata*, Linn. fil. | | Fuchsia *coccinea*, Ait. |
| Gunnera *monoica*, Raoul. | Gunnera *cordifolia*, H.f. | Gunnera *Magellanica*, Lam. |
| Metrosideros *florida*, Sm. | Metrosideros *corifolia*, Vent. | Metrosideros *stipularis*, H.f. |
| Myrtus *pedunculata*, H.f. | | Myrtus *Nummularia*, Poir. |
| Eugenia *Maire*, A. Cunn. | | Eugenia *Darwinii*, H.f. |
| Carpodetus *serratus*, Forst. | | Escallonia *serrata*, Sm. |
| Weinmannia *sylvicola*, B. et S. | Tetracarpæa *Tasmanica*, H.f. | |
| Donatia *Novæ-Zelandiæ*, H.f. | | Donatia *fascicularis*, Forst. |
| Pozoa *trifoliolata*, H.f. | Pozopsis *cordifolia*, Hook. | Azorella *Ranunculus*, D'Urv. |
| Oreomyrrhis *Colensoi*, H.f. | Oreomyrrhis *sessiliflora*, H.f. | Oreomyrrhis *Andicola*, Endl. |
| Panax *simplex*, Forst. | Panax *Gunnii*, H.f. | Panax *nov. sp.* |
| Olearia *operina*, H.f. | Olearia *phlogopappa*, DC. | Chiliotrichum *amelloides*, Cass. |
| Celmisia *gracilenta*, H.f. | Celmisia *asteliæfolia*, A.C. | |
| Lagenophora *Forsteri*, DC. | Lagenophora *montana*, H.f. | Lagenophora *Commersonii*, Cass. |
| Eurybiopsis *Australis*, H.f. | Eurybiopsis *scabrida*, H.f. | |
| Brachycome *radicata*, H.f. | Brachycome *scapiformis*, DC. | |
| Craspedia *fimbriata*, DC. | Craspedia *Richea*, Cass. | |
| Trineuron *pusillum*, H.f. | Scleroleima *Forsteroides*, H.f. | Abrotanella *emarginata*, Cass. |
| Cassinia *Vauvilliersii*, H.f. | Cassinia *cuneifolia*, A.C. | |
| Ozothamnus *glomeratus*, H.f. | Swammerdammia *Antennaria*, DC. | |
| Leptinella *dioica*, H.f. | Leptinella *intricata*, H.f. | Leptinella *scariosa*, Cass. |
| Raoulia *Australis*, H.f. | Raoulia *Tasmanica*, H.f. | |
| Microseris *Forsteri*, H.f. | Microseris *Forsteri*, H.f. | Microseris *pygmæa*, DC. |
| Forstera *clavigera*, H.f. | Forstera *bellidifolia*, Hook. | Forstera *muscifolia*, Willd. |

| NEW ZEALAND, ETC. | AUSTRALIA AND TASMANIA. | TEMPERATE AND COLD S. AMERICA. |
|---|---|---|
| Pratia *angulata*, H.f. | Pratia? *irrigua*, H.f. | Pratia *repens*, Gaud. |
| | Pernettya *Tasmanica*, H.f. | Pernettya *pumila*, Hook. |
| Gaultheria *antipoda*, Forst. | Gaultheria *hispida*, Br. | Gaultheria *microphylla*, H.f. |
| | Prionotes *cerinthoides*, Br. | Lebetanthus *mucronatus*, Endl. |
| Dracophyllum *squarrosum*, H.f. | Dracophyllum *Milligani*, Hook. | |
| Olea *Cunninghamii*, H.f. | Notelea *ligustrina*, Vent. | |
| Gentiana *montana*, Forst. | Gentiana *montana*, Forst. | Gentiana *Magellanica*, Gaud. |
| Parsonsia *heterophylla*, A. C. | Lyonsia *straminea*, Br. | |
| Myosotis *capitata*, H.f. | Myosotis *australis*, Br. | Myosotis *albiflora*, B. et S. |
| Solanum *aviculare*, Forst. | Solanum *aviculare*, Forst. | Solanum *tuberosum*, L. |
| Veronica *elongata*, Benth. | Veronica *calycina*, Br. | |
| Calceolaria *Sinclairi*, Hook. | | Calceolaria *punctata*, Vahl. |
| Mimulus *repens*, Br. | Mimulus *repens*, Br. | Mimulus *luteus*, L. |
| Ourisia *macrophylla*, Hook. | Ourisia *integrifolia*, Br. | Ourisia *Magellanica*, Comm. |
| Euphrasia *cuneata*, Forst. | Euphrasia *collina*, Br. | Euphrasia *Antarctica*, Benth. |
| Gratiola *sexdentata*, A. C. | Gratiola *latifolia*, Br. | Gratiola *Peruviana*, L. |
| Scutellaria *humilis*, Br. | Scutellaria *humilis*, Br. | Scutellaria *nummulariæfolia*, H.f. |
| Myoporum *lætum*, Forst. | Myoporum *insulare*, Br. | |
| Plantago *carnosa*, Br. | Plantago *carnosa*, Br. | Plantago *barbata*, Forst. |
| Rumex *flexuosus*, B. et S. | Rumex *fimbriatus*, Br. | Rumex *cuneifolius*, Camp. |
| Laurelia *Novæ-Zelandiæ*, A. C. | Atherosperma *moschata*, Lab. | Laurelia *aromatica*, Juss. |
| Knightia *excelsa*, Br. | Telopea *truncata*, Br. | Embothrium *coccineum*, Forst. |
| | Lomatia *tinctoria*, Br. | Lomatia *ferruginea*, Br. |
| Drapetes *Lyallii**, H.f. | Drapetes *Tasmanica*, H.f. | Drapetes *muscosa*, Lam. |
| Pimelia *arenaria*, Cunn. | Pimelia *sericea*, Br. | |
| Exocarpus *Bidwillii*, H.f. | Exocarpus *humifusa*, Br. | |
| Australina *Novæ-Zelandiæ*, H.f. | Australina *Tasmanica*, H.f. | |
| | Fagus *Gunnii*, H.f. | Fagus *Antarctica*, Forst. |
| Fagus *Menziesii*, H.f. | Fagus *Cunninghamii*, Hook. | Fagus *betuloides*, Mirb. |
| Phyllocladus *trichomanoides*, Don. | Phyllocladus *aspleniifolia*, Rich. | |
| Athrotaxis *cupressinus*, Don. | Thuja *Doniana*, Hook. | Thuja *tetragona*, Hook. |
| Dacrydium *Colensoi*, Hook. | Dacrydium *Franklinii*, H.f. | |
| Rhipogonum *scandens*, Forst. | Rhipogonum *album*, Br. | |
| Herpolirion *Novæ-Zelandiæ*, H.f. | Herpolirion *Tasmaniæ*, H.f. | |
| Libertia *ixioides*, Spreng. | Renealmia *paniculata*, Br. | |
| Callixene *parviflora*, H.f. | Drymophila *cyanocarpa*, Br. | Callixene *marginata*, Com. |
| Rostkovia *gracilis*, H.f. | | Rostkovia *grandiflora*, H.f. |
| Astelia *linearis*, H.f. | Astelia *alpina*, Br. | Astelia *pumila*, Br. |
| Alepyrum *pallidum*, H.f. | Alepyrum *Pumilio*, Br. | |
| Gaimardia *setacea*, H.f. | | Gaimardia *Australis*, Gaud. |
| Oreobolus *pectinatus*, H.f. | Oreobolus *Pumilio*, Br. | Oreobolus *obtusangulus*, Gaud. |
| Carpha *alpina*, Br. | Carpha *alpina*, Br. | Carpha *schœnoides*, B. et S. |
| Sarcochilus *adversus*, H.f. | Sarcochilus *falcatus*, Br. | |

* The specific name of this species has been, by some mistake, replaced by that of *muscosa* in the body of this work, p. 223; the latter is the original South American species of the genus.

| NEW ZEALAND, ETC. | AUSTRALIA AND TASMANIA. | TEMPERATE AND COLD S. AMERICA. |
|---|---|---|
| Prasophyllum *Colensoi*, H.f. | Prasophyllum *Australe*, Br. | |
| Spiranthes *Novæ-Zelandiæ*, H.f. | Spiranthes *Australis*, Br. | |
| Orthoceras *Solandri*, Lindl. | Orthoceras *strictum*, Br. | |
| Thelymitra *Forsteri*, Sw. | Thelymitra *ixioides*, Sw. | |
| Microtis *porrifolia*, Spr. | Microtis *parviflora*, Br. | |
| Acianthus *Sinclairii*, H.f. | Acianthus *fornicatus*, Br. | |
| Cyrtostylis *oblonga*, H.f. | Cyrtostylis *reniformis*, Br. | |
| Adenochilus *gracilis*, H.f. | Eriochilus *autumnalis*, Br. | |
| Caladenia *minor*, H.f. | Caladenia *carnea*, Br. | |
| Pterostylis *graminea*, H.f. | Pterostylis *longifolia*, Br. | |
| Nematoceras *macrantha*, H.f. | Corysanthes *fimbriata*, Br. | |
| Gastrodia *Cunninghamii*, H.f. | Gastrodia *sesamoides*, Br. | |
| Cheiloglottis *cornuta*, H.f. | Cheiloglottis *diphylla*, Br. | |

Enough is here given to show that many of the peculiarities of each of the three great areas of land in the southern latitudes are representative ones, effecting a botanical relationship as strong as that which prevails throughout the lands within the Arctic and Northern Temperate zones, and which is not to be accounted for by any theory of transport or variation, but which is agreeable to the hypothesis of all being members of a once more extensive flora, which has been broken up by geological and climatic causes.

I have alluded to Pacific Island peculiarities in the New Zealand Flora; these are few, but very well marked by some otherwise local genera, as *Coprosma, Astelia, Exocarpus, Dammara, Geniostoma, Cyathodes, Santalum, Elatostemma, Ascarina, Cordyline,* and others, of which *Ascarina* is the most remarkable, as the genus has hitherto been found nowhere but in New Zealand and the Sandwich Islands. Until the New Caledonian and Hebridean vegetation especially is known, however, we cannot follow out this affinity, as I do not doubt that their rich floras will connect the Botany of the Pacific, Australian, New Zealand, and Malay Islands in a very remarkable manner, and exhibit affinities of the utmost importance.

There has lately indeed been discovered a most remarkable and unique instance of representation by close botanical affinity between very distant spots, viz. the existence of three of the most peculiar Antarctic, New Zealand, and Tasmanian genera on the lofty mountain of Kini-Balu, in Borneo, situated under the equator, viz. *Drapetes, Phyllocladus,* and *Drimys**.

## § II. ON THE VARIATION OF NEW ZEALAND SPECIES.

The difficulty of reducing the variations of species or of their organs to any system is confessedly very great, and I have not the necessary materials for arranging such data as the New Zealand Flora affords; still there are certain facts which appear of great importance in the consideration of the general character of any flora, but which are almost invariably overlooked, because in the present

* These formed part of a very small collection made by H. Low, Esq., most of which I have described in the 'Icones Plantarum,' vol. x.; they were gathered at about 8000 feet elevation, and consisted of a mixture of Australian, Antarctic, and Indian forms. Amongst the latter, many species of Rhododendron prevailed,—a genus unknown south of the equator in the Old World, and here associated with *Dacrydium, Epacrideæ*, and the above-mentioned Antarctic genera, which are almost unknown in the northern hemisphere.

state of our knowledge they are not of practical application. Such are—1. The relative number and extent of genera, the limits to whose species it is difficult to assign, owing to the variableness of their organs.—2. The number of species which materially vary by altering their form and habit during different periods of their growth, and of those whose variations seem independent of age, climate, or condition.

There are many minor considerations that are equally well worthy of study with the above, but which can only be treated of in detail, and studied by local botanists; such as variation in size, stature, colour, and many other particulars which do not produce any generally admitted difficulty in recognizing species.

1. The genera whose species are extremely variable are—

Of very general distribution, 45:—

| | | | | |
|---|---|---|---|---|
| Clematis. | Taraxacum. | Gaultheria. | Parietaria. | Pelargonium. |
| Ranunculus. | Lobelia. | Polygonum. | Dodonæa. | Sonchus. |
| Linum. | Euphrasia. | Hypericum. | Senecio. | 5 gen. Cyperaceæ. |
| Geranium. | Cardamine. | Apium. | Calystegia. | 10 gen. Grasses. |
| Oxalis. | Rubus. | Olea. | Potamogeton. | |
| Epilobium. | Wahlenbergia. | Urtica. | Veronica. | |
| Gnaphalium. | Plantago. | Gentiana. | Luzula. | |

Endemic, or of confined geographical distribution, 34:—

| | | | | |
|---|---|---|---|---|
| Pittosporum. | Pimelia. | Oreomyrrhis. | *Carmichælia. | Microtis. |
| Coriaria. | Oreobolus. | Craspedia. | *Tupeia. | Weinmannia. |
| Cassinia. | *Hoheria. | Trophis. | Ozothamnus. | *Alseuosmia. |
| Elatostemma. | Leptospermum. | Aristotelia. | Leptocarpus. | Parsonsia. |
| Pterostylis. | Dracophyllum. | Coprosma. | Elæocarpus. | Calorophus. |
| *Anisotome. | Prasophyllum. | Ourisia. | Leptinella. | Calceolaria. |
| Celmisia. | *Phormium. | Thelymitra. | Santalum. | |

(*a.*) The first obvious result of this classification is the great number of variable genera, amounting to 79 out of 282, or upwards of one-third; and that the more or less local genera are rather more variable than the widely diffused; for I find in the whole flora that those genera common to all quarters of the globe are to those confined chiefly to Australia and Tasmania as 132 to 150, or nearly one-half of the whole flora: whereas the variable local genera are to the variable widely distributed in the proportion of 34 to 45. As, however, the division into local and peculiar genera is somewhat arbitrary, and that into variable and constant much more so, these conclusions are necessarily vague. Perhaps a more intelligible comparison may be made by examining the absolutely endemic genera. Of these there are 27, or one-tenth of all the genera in the flora, and six only (or one-fifth) of these are very variable; whence it would appear that there is absolutely less tendency to vary, amongst the endemic genera, than amongst those more widely dispersed.

(*b.*) With regard to the widely diffused genera that are variable in New Zealand, most of them are so in all quarters of the globe, but present little uniformity in amount of variation; thus *Rubus*, of which there is only one in New Zealand, and that an extremely variable species, has very few representatives in Australia, and those not particularly variable; very many in

* Those marked with an asterisk are either absolutely peculiar to New Zealand, or found elsewhere in Norfolk Island only, as *Phormium;* or in Lord Auckland's Group, as *Anisotome.*

Europe*, and those highly sportive; and in the Himalaya, the head-quarters of the genus, there are still more species, and those (comparatively speaking) by no means variable. Again, *Clematis, Ranunculus, Epilobium, Apium, Lobelia, Wahlenbergia, Gaultheria, Olea, Gentiana, Calystegia, Euphrasia, Luzula,* and *Poa,* all very cosmopolitan, are as variable in New Zealand as elsewhere, and some of them more so; but as they are not as equally represented in number of species in New Zealand as elsewhere, the results presented by each genus are of very different value. Thus *Lobelia* and *Wahlenbergia,* though very large genera indeed in many parts of the globe where the species are not conspicuously protean, are represented in New Zealand by two widely diffused and exceptionally protean species. *Potamogeton* and *Poa* (with many others) belong to a class equally common in New Zealand and elsewhere, and equally variable everywhere. *Epilobium, Veronica, Senecio,* and others, bear a larger proportion to the New Zealand Flora than to any other Flora of equal area and number of species, and are decidedly as variable in New Zealand as anywhere.

(*c.*) If we turn to the sparingly diffused and endemic genera, the same want of any recognizable relations between extent of geographical distribution, number of species, and their variation, prevails, rendering vain any attempt to characterize them by such general terms as shall convey a more accurate or definite idea, than, that in whatever light we regard them they are all very variable; the absolutely local and well-marked genera, as *Alseuosmia, Hoheria,* and *Carmichælia,* being quite as much as or more so than the others. This leads to the last remark.

(*d.*) Are the New Zealand plants more variable than those of other countries? This it is almost impossible to answer, except by giving the general impressions (and such are but too often fallacious) received during my examinations; and may, I conceive, be better put thus—Have I had comparatively more difficulty in working out New Zealand plants than those of other countries to whose floras I have paid equal attention? I here again find almost insuperable obstacles to a direct answer. If I have met with fewer difficulties in other floras, as in those of Tasmania, Europe, and the Antarctic regions, it may be because my materials were better, and more assistance was available from my predecessors, and not because the species were less variable; again, if I have met with unusual difficulties in the New Zealand Flora, it is certainly in a great measure to be accounted for by the very great natural obstacles in the way of a right understanding of the Natural Orders, genera, and species, some of which I have mentioned at p. xxvii. Upon the whole, I do think that the New Zealand genera are in proportion to their numbers more variable than those of other countries whose botany I have investigated, whether insular or continental; but I do not wish to express this opinion so decidedly as to warrant any conclusion being drawn from it.

In the British Flora I find fully seventy widely distributed genera (out of about 512) containing species as variable proportionally as any in New Zealand, besides many others containing but one or two very sportive species.

In Tasmania and Australia some of the largest genera (as *Eucalyptus*) are the most protean in every point of view, the older individuals of each species not only differing widely from the younger, but also from each other in stature, habit, and botanical characters. In *Acacia,* on the other hand, while the young states of many individual species differ from the old as much as in *Eucalyptus,* the latter are easily limited by constant characters in most important organs. In a third immense endemic Australian genus, *Banksia,* the species are very local, and constant as to form; whilst in a fourth equally large and almost equally local genus of the same order, *Persoonia,* the species vary

* Except, indeed, we admit with many excellent botanists, and perhaps with all our best ones, that the majority of the European species are reducible to a very few.

much. Enough has been adduced to show that this subject is most difficult and obscure, and I may add that it is one in which hasty generalization from first impressions has given rise to much error.

2. Genera whose species alter in form or habit. These are—*Hymenanthera, Pittosporum, Plagianthus, Melicope, Discaria, Edwardsia, Carmichælia, Ackama, Panax, Aralia, Carpodetus, Coprosma, Parsonsia, Olea, Weinmannia, Dammara, Thuja, Podocarpus, Dacrydium, Phyllocladus, Rhipogonum.*

Many of the above vary so remarkably that botanists have been greatly puzzled by the abnormal forms they present: thus a state of *Hymenanthera crassifolia* has been referred to *Goodenia*, one species of *Weinmannia* has been made into two genera, and an *Olea* has been converted into a *Metrosideros*. Some states of *Plagianthus urticinus* and of *Carpodetus serratus* (plants of two very different Natural Orders) are almost undistinguishable, and so are *Hymenanthera crassifolia* and *Pittosporum obcordatum;* so also *Melicytus micranthus, Panax anomala,* and *Melicope simplex,* are often so extremely like one another in foliage as to be confounded when in a dry state. With regard to *Carmichælia, Ackama, Weinmannia,* most of the *Araliaceæ, Coprosma, Parsonsia,* and some of the Pines, the variation is greatest in amount between old and young plants; but with *Discaria, Hymenanthera, Pittosporum,* some species of *Coprosma, Olea,* and many Pines, there seems to be no law, abnormally formed organs appearing on the same branches with normal ones.

From the above list it would appear that variability of this nature is most frequent amongst more or less endemic genera and species, but whether in this respect the New Zealand Flora is more variable than others I have not proved. The Yew, Cedar, Holly, Ivy, and especially Furze and Juniper, perhaps vary in Europe as much as, or more than, the above; but it is difficult to appreciate the amount of variability in a familiar object. On the whole I am inclined to think that the New Zealand Flora is remarkable for the number of plants which vary thus, but that this peculiarity is rendered conspicuous by the prevalence of *Coniferæ* and *Araliaceæ,* which are variable in all parts of the world.